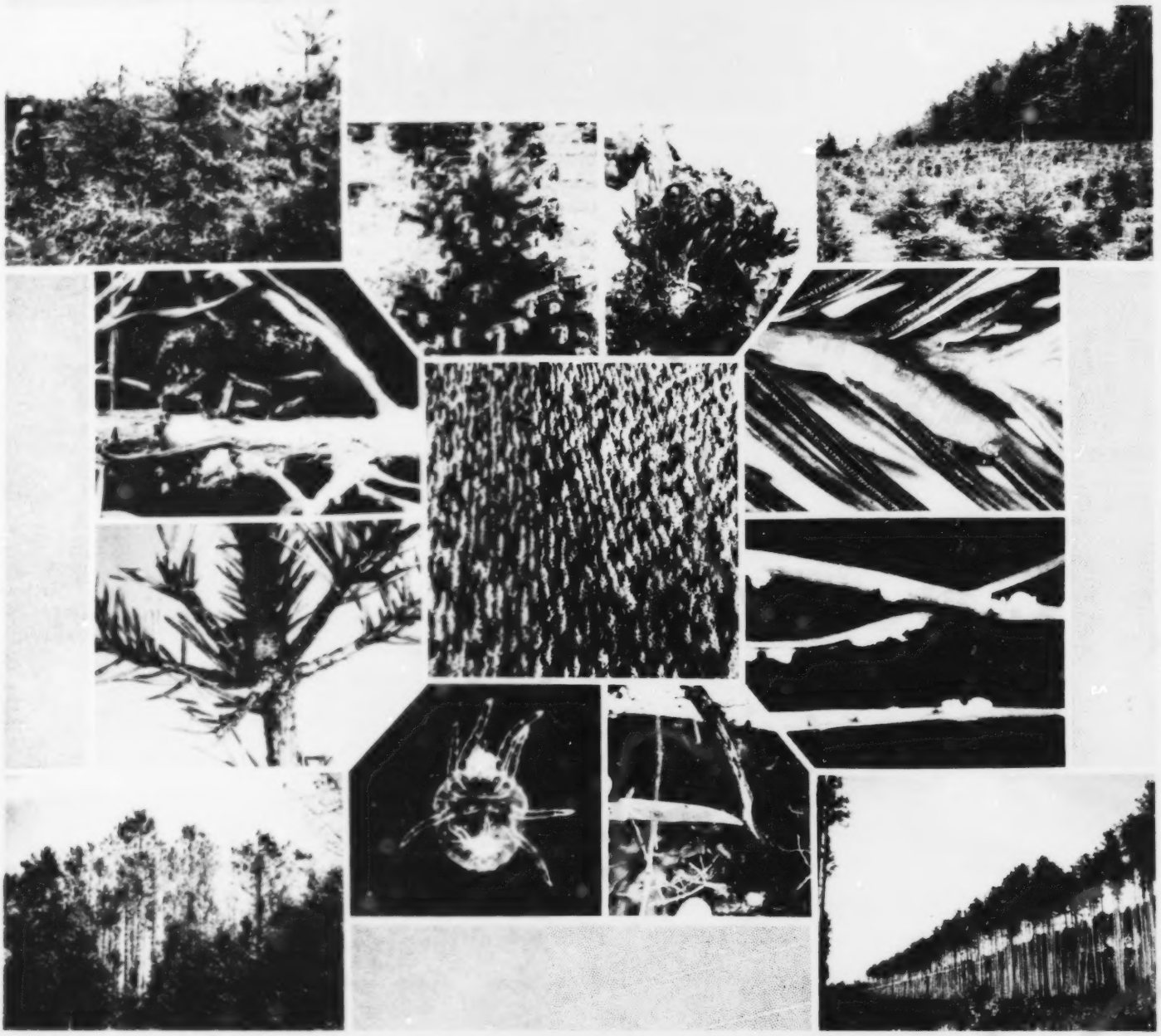
Government of Canada
Gouvernement du Canada

Canadian Forestry Service
Service canadien des forêts

Forest pest conditions in the Maritimes 1986

Laszlo P. Magasi

Information Report M-X-161
Canadian Forestry Service — Maritimes



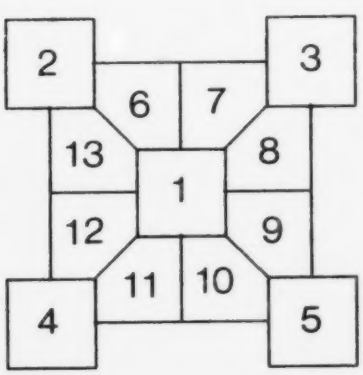
87-04369/

CANADIAN FORESTRY SERVICE — MARITIMES

The Canadian Forestry Service - Maritimes is one of six regional establishments of the Canadian Forestry Service, within Agriculture Canada. The Centre conducts a program of work directed toward the solution of major forestry problems and the development of more effective forest management techniques for use in the Maritime Provinces.

The program consists of three major elements - research and development, technical and information services, and forest resources development. Most research and development work is undertaken in direct response to the needs of forest management agencies, with the aim of improving the protection, growth, and value of the region's forest resource for a variety of consumptive and nonconsumptive uses; studies are often carried out jointly with provincial governments and industry. The Centre's technical and information services are designed to bring research results to the attention of potential users, to demonstrate new and improved forest management techniques, to assist management agencies in solving day-to-day problems, and to keep the public fully informed on the work of the Maritimes Centre.

The forest resources development branch is responsible for development, implementation, and administration of joint federal/provincial forest resources development agreements in the three Maritime provinces, for the creation of employment opportunities in the development of the forest resources, and for providing economic information to landowners and decision-makers for identifying and evaluating forest management alternatives.



1. Spruce plantation
2. Jack pine - plantation assessment
3. Young balsam fir plantation
4. Sirococcus damaged red pine
5. Strip cut to encourage red pine regeneration
6. Frost damaged balsam fir
7. Spruce bud moth damaged white spruce
8. Spruce bud moth larvae
9. Needle rust on pine
10. Armillaria root rot
11. Spider mite
12. Northern pitch twig moth
13. Seedling debarking weevil

FOREST PEST CONDITIONS IN THE MARITIMES IN 1986

by

Laszlo P. Magasi

CFS - Maritimes

Fredericton, New Brunswick

Information Report M-X-161

Government of Canada

Canadian Forestry Service

1987

©Minister of Supply and Services, Canada 1987

Catalogue no. Fo46-19/161E
ISBN 0-662-15371-5
ISSN 0834-406X

Copies of this report may be obtained at no charge from

Canadian Forestry Service - Maritimes
P.O. Box 4000
Fredericton, N.B. Canada E3B 5P7

Une traduction française de ce rapport peu être mise sans frais à la disponibilité de quiconque en fait la demands.

ABSTRACT

This report reviews the status of forest insects and diseases in the Maritimes Region in 1986, and forecasts conditions for 1987, when appropriate. Economically important pests of current concern are discussed in some detail, other organisms are listed in tabular form. A separate chapter discusses the various special involvements with related activities such as the use of pheromones as survey tools, the Acid Rain National Early Warning System (ARNEWS) and others. A list of forest-pest related publications and reports is included. More detailed information is available from the Canadian Forestry Service - Maritimes.

RESUME

Ce rapport fait le bilan des insectes et maladies des arbres la région des Maritimes in 1986, et donne un aperçu des conditions prévues pour 1987, lorsqu'approprié. Les ravageurs dans d'importance courante y sont traités en détail, les autres organismes sous forme tabulaire seulement. Un chapitre en particulier explique les implications du RIMA dans des activités connexes, telles que l'usage de phéromones comme outils de relevé, le Dispostif National d'Alterte Rapide pour les Pluies Acides (DNARPA), et autres efforts. On y inclus une liste de publications et de rapports traitant de ravageurs forestiers. De plus amples renseignements sont disponibles au Service canadien des forêts - Maritimes.

TABLE OF CONTENTS

ABSTRACT i

INTRODUCTION 1

SUMMARY 3

IMPORTANT AND CONSPICUOUS FOREST PESTS 5

SPRUCE BUDWORM 6

STILLWELL'S SYNDROME 8

BARK BEETLES OF CONIFERS 8
Spruce Beetle 9
Eastern Larch Beetle 10

CANKERS OF CONIFERS 10
European Larch Canker 10
Scleroderris Canker 11

SEEDLING DEBARKING WEEVIL 11

SIROCOCCUS SHOOT BLIGHT 13

SPRUCE BUD MOTH 13

ARMILLARIA ROOT ROT 14

RUSTS ON CONES, NEEDLES AND LEAVES 15
on Balsam Fir 16
on Hemlock 16
on Larch 16
on Pine 16
on Spruce 17
on Ash 17
on Poplar 17

GYPSY MOTH 18

FOREST TENT CATERPILLAR 20

OTHER HARDWOOD DEFOLIATORS 22
Fall Cankerworm 22
Oak Leaf Shredder and Oak Leafroller 22
Lesser Maple Spanworm 23

CASEBEARERS, LEAFMINERS AND SKELETONIZERS 23
on Birch 23
on Larch 24
on Poplar 24

DUTCH ELM DISEASE 24

DETERIORATION OF WHITE BIRCH ALONG THE BAY OF FUNDY 26

CONDITION OF SUGAR MAPLE 27

MITES 28

WHITEMARKED TUSSOCK MOTH 30

HEMLOCK LOOPER 31

SEED ORCHARD PESTS 31

NURSERY AND GREENHOUSE PESTS 32

CHRISTMAS TREE PESTS 32
Balsam Gall Midge 32
Balsam Twig Aphid 32
Yellow Witches' Broom of Balsam Fir 33

SPECIAL SURVEYS 35

ACID RAIN NATIONAL EARLY WARNING SYSTEM 36

FOREST PEST ASSESSMENT IN PLANTATIONS 37

CYCLICAL REVIEWS FOR SPECIFIC PESTS 42

PINEWOOD NEMATODE 42

PHEROMONE SURVEYS 44

THE LIGHT TRAP MONITORING SYSTEM 45

OTHER INSECTS AND DISEASES 53

ACKNOWLEDGEMENTS 65

LIST OF PUBLICATIONS 66

INTRODUCTION

Some of the objectives of the Forest Insect and Disease Survey are to monitor insect and disease conditions, determine their effects on the forest, and report on the status of important and common pests. In the Maritimes, this information is disseminated to interested agencies and individuals through periodic reports such as Seasonal Highlights, Technical Notes, Information Reports, and the Annual Report of the Forest Insect and Disease Survey.

In this report, pest conditions in 1986 are described; operational control programs against the spruce budworm are summarized; forest-pest-related research programs connected with the aims of the Forest Insect and Disease Survey are briefly mentioned; and a list of reports and publications relating to forest-pest conditions is included.

The report aims to provide forest managers with information on pest conditions in the Maritime Provinces, early enough to be considered in management decisions before the start of the 1987 field season. Insects and diseases that were widespread and caused considerable concern in 1986 are discussed in detail, others are presented in tabular form. More information on these and on other specific conditions will be provided upon request from CFS-Maritimes.

Since 1982, we have presented a chapter on special surveys to report on some of our projects that have implication in forest management but did not fit our previous reporting format. In 1986 this chapter includes a summary of a plantation survey carried out in New Brunswick in cooperation with the Department of Natural Resources and Energy, J.D. Irving Ltd., and Fraser Inc.; a regional survey for the pinewood nematode, a pest of importance to international commerce and of concern to plant quarantine organizations; a brief statement on the status of work on pheromones and other attractants used as tools for detecting the presence and monitoring the spread and fluctuation of forest insects; and a section that deals with the Acid Rain National Early Warning System (ARNEWS).

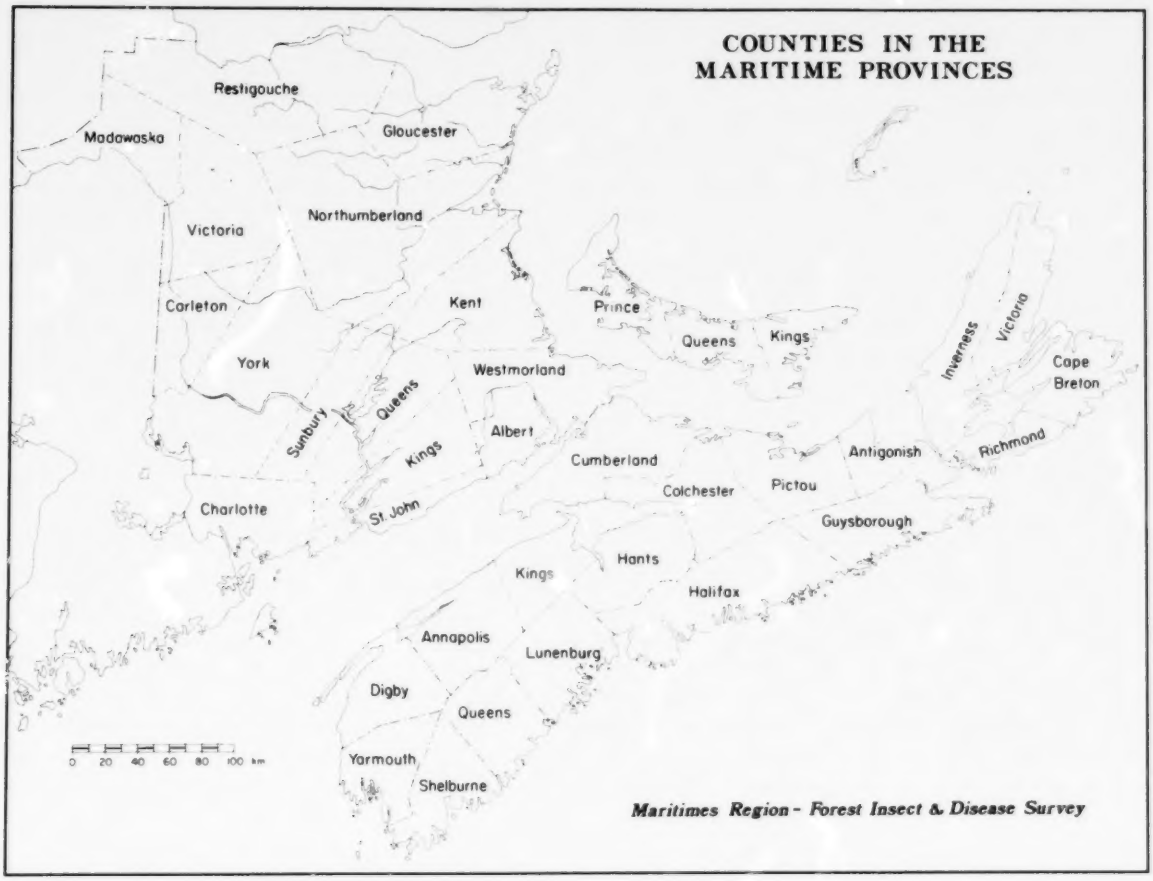
We attempt to add extra information on the pest discussed, in response to suggestions, and because requests for information indicate the need for this, now that our readership has expanded beyond our traditional clientele of the forestry community. This, we hope, will place the organism in a better perspective and provide readers with some background and a clearer understanding of the concerns we express. Comments on any part of the report for improved presentation are always welcome.

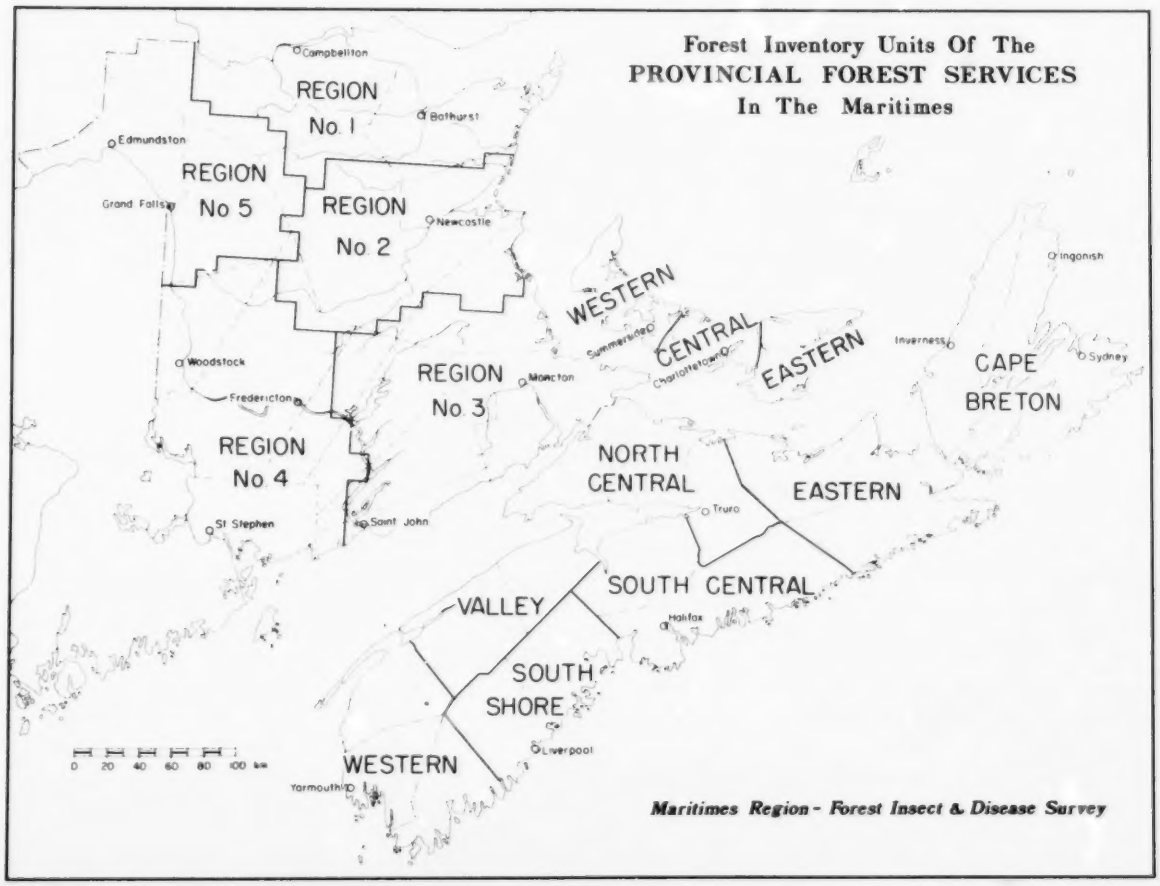
Two maps are included to help the reader locate areas mentioned. One shows the counties of the three provinces, and the other indicates the provincial forest services' forest inventory subdivisions.

In recent years, efforts towards collecting and reporting information in quantitative terms have been emphasized, but for a variety of reasons, it will never be possible to express all observations quantitatively. Throughout this report, the terms "severe, moderate, light, and trace" are used to describe the level of defoliation and, in some cases, other injury or insect population levels. Unless otherwise stated, the terms have the following ranges:

Trace up to 5%
Light 6 - 29%
Moderate 30 - 69%
Severe 70 - 100%

After celebrating the 50th anniversary of the formation of the Forest Insect and Disease Survey in 1986 the cover of this report, reverts to the usual practice of featuring a forest pest or some specific survey activity. To emphasize the importance of plantations to forestry and particularly to recognize the fact that pest surveys are the first step in protecting them, we are featuring plantation surveys and some of the important pests affecting this future forest.


COUNTIES IN THE
MARITIME PROVINCES
Restigouche
Madawaska
Gloucester
Victoria
Northumberland
Carleton
Kent
Prince
Queens
Kings
Inverness
Victoria
Cape
Breton
York
Westmorland
Sunbury
Queens
Albert
Kings
Cumberland
Antigonish
Richmond
Colchester
Pictou
Charlotte
St. John
Guysborough
Hants
Kings
Halifax
Annapolis
Lunenburg
Digby
Queens
0 20 40 60 80 100 km
Yarmouth
Shelburne
Maritimes Region - Forest Insect & Disease Survey


Forest Inventory Units Of The
PROVINCIAL FOREST SERVICES
In The Maritimes
Campbellton
REGION
No. 1
Bathurst
Edmundston
REGION
No 5
Grand Falls
REGION
No. 2
Newcastle
WESTERN
Summerside
CENTRAL
Charlottetown
EASTERN
Inverness
Tingonish
Sydney
CAPE
BRETON
Woodstock
REGION
No. 3
Moncton
Fredericton
REGION
No. 4
NORTH
CENTRAL
EASTERN
St. Stephen
Saint John
Truro
SOUTH CENTRAL
VALLEY
Halifax
SOUTH
SHORE
Liverpool
0 20 40 60 80 100 km
WESTERN
Yarmouth
Maritimes Region - Forest Insect & Disease Survey

SUMMARY

In 1986, **spruce budworm** caused moderate and severe defoliation over 927 000 ha in New Brunswick, 288 600 ha in Nova Scotia and 64 600 ha in Prince Edward Island. Control operations were conducted over 545 500 ha in New Brunswick and 58 177 ha in Nova Scotia. It is predicted that infestations in 1987 will affect about 1.7 million hectares of forest in New Brunswick. In Nova Scotia, populations capable of causing damage are expected on the northern mainland in 1987. In Prince Edward Island, a decrease is predicted in the area of moderate and severe defoliation and most of this is expected to be in Queens and southeastern Kings counties.

Stillwell's syndrome, the sudden death of balsam fir trees, mostly in spruce budworm affected stands, reached near epidemic proportions over large areas in the western half of New Brunswick. Accumulating losses because of this condition have prompted the consideration of salvage operations by some companies.

Spruce beetle remained active in the few infested areas of southern New Brunswick and was observed in other parts of the Province. The decline of major outbreaks continued in both Nova Scotia and Prince Edward Island but not before the insect has caused considerable white spruce mortality in the provinces.

Eastern larch beetle populations continued on the downward trend started in 1984 over much of the Region but leaving behind large numbers of killed trees. An average of 4.3% of the trees died annually on an observation plot during the past seven years.

European larch canker remained confined to southeastern New Brunswick and mainland Nova Scotia.

The North American race of **Scleroderris canker** was found in only one area of New Brunswick. The European race of the disease was not obtained from any of the eight areas under surveillance for the fifth consecutive year.

The **seedling debarking weevil** has caused considerable seedling mortality in all three provinces with damage being most serious in eastern mainland Nova Scotia and southeastern Prince Edward Island. This insect has become one of the major threats to the success of plantation establishment and efforts are under way to minimize losses.

Sirococcus shoot blight remained the most serious plantation problem of red pine in western Nova Scotia and also caused damage in Prince Edward Island and southern New Brunswick. It was shown that young plantations within 1 km of older red pine stands are at high risk for early infection and that the disease intensifies and may progress to the tree killing stage as plantations become older.

Spruce bud moth was widespread in the Maritimes and there was slight increase in populations in some areas. An average of 10% of the white spruce shoots were affected in both New Brunswick and Nova Scotia. In Prince Edward Island damage was higher at the few locations where observations were made.

Armillaria root rot killed both young and old trees. The disease was common in young spruce and pine plantations and at least some tree mortality was recorded in 22% of 141 plantations assessed in New Brunswick.

A number of **rusts** affected various coniferous and hardwood species but the only major problem encountered in 1986 was the ash rust, a persistent disease mostly on ornamentals in Nova Scotia. The needle rust on jack pine in New Brunswick plantations, common at damaging levels in past years, was still widespread in 1986 but the intensity of infection was much reduced.

Gypsy moth populations remained generally low in the infested areas, most represented by only a few egg masses. The insect made further inroads in southwestern New Brunswick as the known distribution extended inland. In Nova Scotia only minor shifts occurred in distribution. The Gypsy Moth Coordinating Committee was again in charge of overseeing all cooperative surveys.

Forest tent caterpillar outbreaks drastically declining in past few years, collapsed and the insect is not considered a major forest pest at present. The only residual population, in eastern mainland Nova Scotia, is expected to collapse in 1987.

Other hardwood defoliators of some significance in 1986 included the fall cankerworm, oak leaf shredder, oak leafroller, and lesser maple spanworm. Large-scale defoliation was caused only by the fall cankerworm which defoliated some 23 000 ha of forest in patches distributed throughout western Nova Scotia. The other insects were largely of local concern. The populations of the lesser maple spanworm declined sharply in eastern New Brunswick.

Birch casebearer, birch leafminer and **birch skeletonizer** caused various levels of foliage browning in many areas throughout the Region although the degree of leaf browning was lower than in previous years. **Larch casebearer** populations collapsed and the predicted large-scale defoliation, especially in western and central Nova Scotia did not materialize. **Poplar serpentine leafminer** was again

common on trembling aspen in northern New Brunswick and caused various levels of foliage discoloration.

Dutch elm disease intensified within the area of known distribution and spread to new areas in all three provinces in 1986. The disease was found for the first time on Deer Island in New Brunswick and in Victoria County, Nova Scotia. Two more infected trees were identified in Prince County, Prince Edward Island in the area where the disease was first found in the Province in 1979. The annual elm tree loss rate in Fredericton dropped below 1% for the first time since 1974. The city still has more than 70% of its original elm tree population after battling the disease for 26 years.

Deterioration of white birch along the Bay of Fundy, due to annually recurring early foliage browning since the late 1970s, continued in 1986. Symptom expression (brown leaves falling early) was much less pronounced than in previous years. The percentage of healthy trees on permanent plots decreased from 93% to 14% between 1982 and 1986. Research is underway to determine the cause of this condition.

A survey to determine the **condition of sugar maple** in New Brunswick showed that only 6.1% of the trees exhibited branch dieback in excess of 25% of the crown affected.

The **Christmas tree pests,** balsam gall midge and balsam twig aphid, were present at generally very low populations in much of the Region and no serious infestations were encountered. Number of new brooms by the yellow witches' broom was lower than in previous years.

Foliage discoloration of pine associated with the presence of various species of **mites** was widespread but generally light throughout the Region. Moderate and severe discoloration occurred only in eastern mainland Nova Scotia.

Whitemarked tussock moth populations have been increasing and the Region. Various levels of defoliation occurred in several areas in eastern Nova Scotia. Further population increases are anticipated in 1987.

Hemlock looper caused defoliation of balsam fir only in a small area in Cumberland County, Nova Scotia.

Seed orchard pests and **nursery and greenhouse pests** did not cause serious problems. However, monitoring forest pests in these high value situations is important because of their low tolerance levels to damage.

The **Acid Rain National Early Warning System** program continued in 1986 with the assessment of conditions on all the ARNEWS plots, collection of foliage for analysis on some, and determination of foliage retention on about 280 locations throughout the Maritimes. Special plots were established to help explain the condition of red spruce.

Cooperative **plantation surveys,** involving federal and provincial forestry services and industry, were conducted in New Brunswick. There were 141 plantations and 14 thinned areas assessed, involving over 12 000 trees. Over 92% of the pine, spruce, and larch trees were classified as healthy.

Pinewood nematode surveys at 185 locations, involving about 400 trees, were conducted in 1985-1986. The pinewood nematode ("r" form) was found in three trees at three different locations in southeastern New Brunswick.

Pheromone surveys, were carried out for spruce budworm (an international, interregional research effort), forest tent caterpillar, jack pine budworm, European pine shoot moth, spruce bud moth, and gypsy moth. All except the spruce budworm and the spruce bud moth, are in at least semi-operational use.

Other insects and diseases encountered in 1986 but not discussed in detail are presented in a tabular form. Remarks explain their current status.

A list of publications dealing with forest insects and diseases, authored or co-authored by staff from CFS-Maritimes is included for reference. About 30 reports are listed.

The Forest Insect and Disease Survey is losing the services of two of its staff members through retirements. Their departure means the loss of 75 years of experience that will be sorely missed.

IMPORTANT AND CONSPICUOUS FOREST PESTS

SPRUCE BUDWORM

Information presented on the spruce budworm, *Choristoneura fumiferana* (Clem.), is summarized from various sources: New Brunswick Department of Natural Resources and Energy, Forest Protection Limited, J.D. Irving Limited, Nova Scotia Department of Lands and Forests, Prince Edward Island Department of Energy & Forestry, and the Canadian Forestry Service-Maritimes. Both published and unpublished data were used with permission, and the cooperation of all organizations is acknowledged. More detailed information is available from the various sources.

NEW BRUNSWICK

Defoliation of balsam fir and spruce stands was recorded on over 1 087 000 ha in the Province in 1986 (Fig. 1). Defoliation was severe on 698 000 ha, moderate on 229 000 ha and recorded as light on 160 000 ha. The total area of defoliation is almost the same as was recorded as moderate and severe in 1985 (1 070 000 ha). The 927 000 ha of moderate and severe defoliation in 1986 represents a 13% decrease from 1985 (1 070 000 ha), a 27% increase from 1984 (730 000 ha) and a considerable (54%) decrease from the 2 028 000 ha recorded in these categories in 1983.

Damage - There were no specific spruce budworm damage surveys conducted by the Forest Insect and Disease Survey in New Brunswick in 1986.

Control operations - Foliage protection against the spruce budworm in New Brunswick was conducted over 545 500 ha in 1986, 496 000 ha by Forest Protection Ltd., 49 500 ha by Forest Patrol Ltd., a subsidiary company of J.D. Irving Ltd.

Forest Protection Ltd. treated 126 000 ha with two applications of Aminocarb (Matacil 180F), 118 000 ha with two applications of fenitrothion (Sumithion) and 141 000 ha received a single application of one chemical, followed by the other. The biological control agent *B.t.* (Dipel 132) was applied over 111 000 ha. The rate of application was 210 g/ha for fenithrothion, 70 g/ha for Aminocarb and 30 BIU/ha for *B.t.* Most of the chemical treatments were applied in water-based formulations while *B.t.* was applied undiluted.

Forest Patrol Ltd. treated all but 30 ha of the 49 500 ha in their program with Aminocarb (Matacil 180F) or fenitrothion (Sumithion). The 30 ha received a single application of *B.t.* (Dipel 132) at the rate of 30 BIU/ha. Over 96% of the chemically treated area received double application, at the rate of 210 g/ha for fenitrothion and 90 g/ha for aminocarb.

Forecast - The traditional egg mass surveys for predicting spruce budworm infestation levels were replaced by the overwintering larval survey (L2) in New Brunswick in 1985. In 1986, the New Brunswick Department of Natural Resources and Energy processed samples from 1586 areas, of which 3% are in the high, 20% in the moderate, and 77% in the low infestation categories. The high and moderate populations of the spruce budworm occur throughout much of the northern part of the Province and in smaller areas, though of considerable size, elsewhere. The total area forecast to support populations capable of causing damaging levels of defoliation in 1987 is about 1.7 million hectares, representing a 46% reduction from 1986.

NOVA SCOTIA

Defoliation of balsam fir and spruce in softwood and mixedwood stands occurred in 431 300 ha in Nova Scotia in 1986. (Fig. 1). Defoliation was severe on 5 900 ha, moderate on 282 700 ha and light on 142 700 ha. The moderate defoliation class includes 76 000 ha where severely defoliated patches were interspersed throughout moderately defoliated areas.

Although the total area of defoliation increased in 1986 from the 345 200 ha recorded in 1985, the area of moderate and severe defoliation categories decreased to 288 600 ha from 318 000 ha reported in 1985. This decrease alone is noteworthy but more important is the fact that while in 1985 all but 32 000 ha of this area was severely defoliated, in 1986 only 5 900 ha falls into that category. All of the noticeable defoliation recorded in the Province occurred in the northern mainland counties of Cumberland, Colchester, Pictou, and Antigonish.

Damage - There were no specific spruce budworm damage surveys conducted by the Forest Insect and Disease Survey in Nova Scotia in 1986.

The condition of balsam fir subjected to an uncontrolled spruce budworm outbreak has been followed on permanent research plots on both the Highland and Lowland areas of Cape Breton Island since 1976. Tables 1 and 2 show the annual tree condition of merchantable balsam fir on these plots from 1976-1985 (Ostaff, in prep.). By the end of 1985, tree mortality, attributed to spruce budworm attack, was 82% on the Highlands and 91% on the Lowlands. Only 10% of the merchantable balsam fir on the Highlands and 6% on the Lowlands survived the outbreak. Although spruce budworm populations decreased drastically in 1981 from those at the height of the outbreak, losses continued to mount with many of the weakened trees falling victim to a complex of secondary organisms, and in recent years to blowdown. The apparent slowdown in losses is a classical case of 'not much left to die' at these levels of stand destruction.

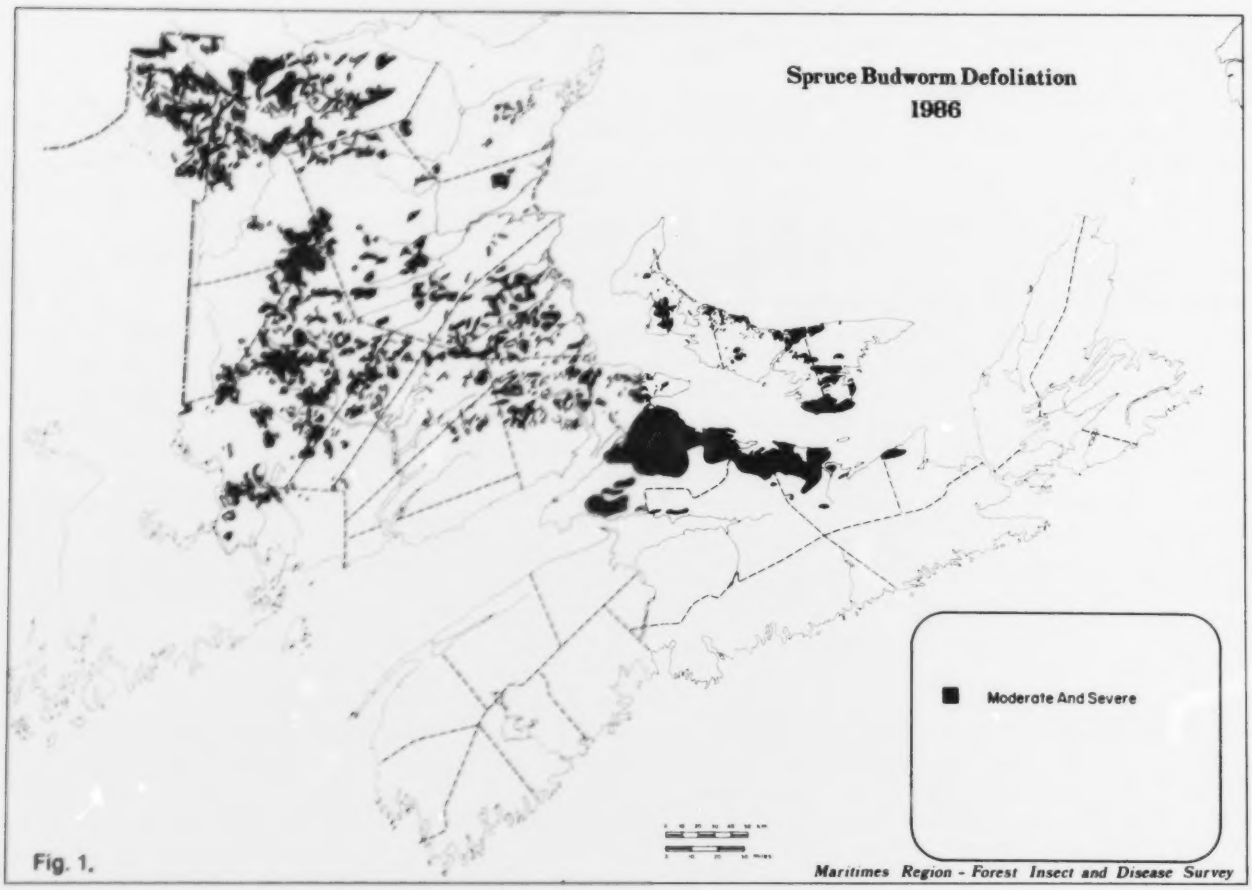


Fig. 1.

Control operations - In 1986, control operations in Nova Scotia were conducted by the Nova Scotia Department of Lands and Forests on 56 155 ha and by J.D. Irving Ltd. on 2 022 ha, for a total of 58 177 ha. The biological control agent *B.t.* (Dipel 132R), at the rate of 30 BIU/ha was the only control agent used. All but 35 ha were treated aerially.

Forecast - Overwintering larval surveys (L2) completely replaced the traditional egg-mass surveys for the first time in Nova Scotia in 1985, and results from these constitute the sole base from which predictions are made. The L2 survey was conducted by the Nova Scotia Department of Lands and Forests, with sampling assistance from Bowater-Mersey Ltd. personnel.

Information from 420 sample locations indicates that while the total area of infestation has not changed much between 1985 and 1986 there is a 90% reduction in the areas of extreme, and a 38% reduction in high infestations. However, there is a 26% increase in the areas of moderate infestations. Populations are negative or low in 12 counties. Moderate population levels are present at 21% of the sample locations in Annapolis County and only one location was 'moderate' in Shelburne County. Most of the infestations were found in Cumberland, Colchester, Pictou, and Antigonish counties on the northern mainland where 5% of the samples indicate extreme, 11% high and 25% moderate infestations. Spruce and fir trees in areas supporting moderate to extreme spruce budworm populations are at risk of noticeable defoliation in 1987.

PRINCE EDWARD ISLAND

Defoliation of balsam fir and spruce stands occurred throughout Prince Edward Island and affected 98 000 ha in 1986. Defoliation was severe on 600 ha, moderate on 64 000 ha and light on 33 400 ha (Fig. 1). The moderate defoliation class includes 23 000 ha where severely defoliated patches were interspersed throughout the moderately defoliated area.

Damage - There were no specific spruce budworm damage surveys conducted by the Forest Insect and Disease Survey in Prince Edward Island in 1986.

Control - No control measures on an operational scale were carried out against the spruce budworm in Prince Edward Island in 1986.

Forecast - Since 1984, the overwintering larval survey (L2) was used in Prince Edward Island to predict populations for the following year. In 1986, the L2 survey included 42 locations throughout the Province. Of these 5% are in the high, 37% in the moderate and 58% in the low or negative infestation category. Compared with results obtained in 1985, when populations were extreme at 9%, high at 33%, moderate at 29%, and low or negative at 29% locations sampled, spruce budworm populations are expected to decrease in 1987. The highest counts were obtained in Queens and in southern Kings counties where the most serious defoliation can be expected. In addition, pockets of moderate defoliation are likely to occur elsewhere.

STILLWELL'S SYNDROME
(Sudden death of balsam fir trees)

Balsam fir trees, usually with a fair complement of foliage despite having been exposed to various amounts of defoliation by the spruce budworm for several years, turn bright red and die. This phenomenon has been known in balsam fir stands where considerable damage or mortality has occurred. The "dropping out" of surviving trees in spruce budworm damaged stands during the apparent recovery stage, even years after the collapse of the outbreak, was noted by the late M.A. Stillwell during his pathological studies in the Green River Watershed of New Brunswick, his native province. In his honor, we proposed to refer to this phenomenon as Stillwell's Syndrome, in 1982 when the Forest Insect and Disease Survey first drew attention to this condition, and discussed it in a separate chapter in its annual report.

Balsam fir trees stressed by repeated spruce budworm defoliation are susceptible to attack by numerous organisms normally considered to be secondary in nature. Investigations in 1982 into the possible cause of Stillwell's Syndrome found that all red trees sampled were affected by Armillaria root rot, *Armillaria mellea* (Vahl ex Fr.) Kummer, and at least one species of beetle. Balsam bark weevil, *Pissodes dubius* Rand., was present in 75% of the affected trees, balsam fir bark beetle, *Pityokteines sparsus* (Lec.), in 17%, and sawyer beetle, *Monochamus* sp. in 17%. However, observations elsewhere indicate that not all Stillwell's Syndrome-killed trees are affected by Armillaria root rot, that balsam bark weevil and balsam fir bark beetle frequently occur together on the same tree; and that sawyer beetle attack of weakened living trees is not uncommon.

Sudden death of balsam fir trees was reported in 1980 and 1981, from various parts of New Brunswick. In 1982, an unusually high number of balsam fir trees died in this manner and some areas of Nova Scotia were affected. The condition was present but much reduced in 1983, increased in 1984, and continued in 1985, especially in the northwestern part of New Brunswick.

In 1986, the problem further intensified in New Brunswick (Fig. 2) and literally thousands of balsam fir trees with bright red foliage were observed during early summer aerial surveys. The condition in the most affected areas of the western part of the Province progressed to the point that small groups of trees rather than individuals were dying. Current tree mortality was in excess of 15% in about one-quarter of the stands in New Brunswick and reached as high as 28% in one area in Restigouche County. As in previous years, the balsam fir bark weevil, *Pissodes dubius* Rand., was the most prevalent secondary insect found associated with the condition. In some areas, spruce trees also appeared to be affected but because of rapid needle loss and the lack of pronounced change in foliage color on this species, the 'sudden death' is not as conspicuous.

Accumulating losses prompted some companies to change forest management plans and to alter cutting programs in order to conduct salvage operations in some of the most seriously affected areas. In Nova Scotia, recently dead balsam fir trees with bright red foliage were observed in the central part of the Province, particularly in Colchester and Cumberland counties and in Victoria County on Cape Breton Island. These trees were widely scattered and often only one or a few trees were affected in any given area. Secondary insects and/or Armillaria root rot were always found associated with the condition.

In Prince Edward Island, only two trees, near Brookvale, Queens County, were classified as having died of the Stillwell's Syndrome.

BARK BEETLES OF CONIFERS

Not as conspicuous as some defoliators, bark beetles nonetheless are an important group of forest insects causing tree mortality. Bark beetles usually attack trees that have been weakened by other factors but when populations are at outbreak levels, healthy trees are successfully attacked and may be killed.

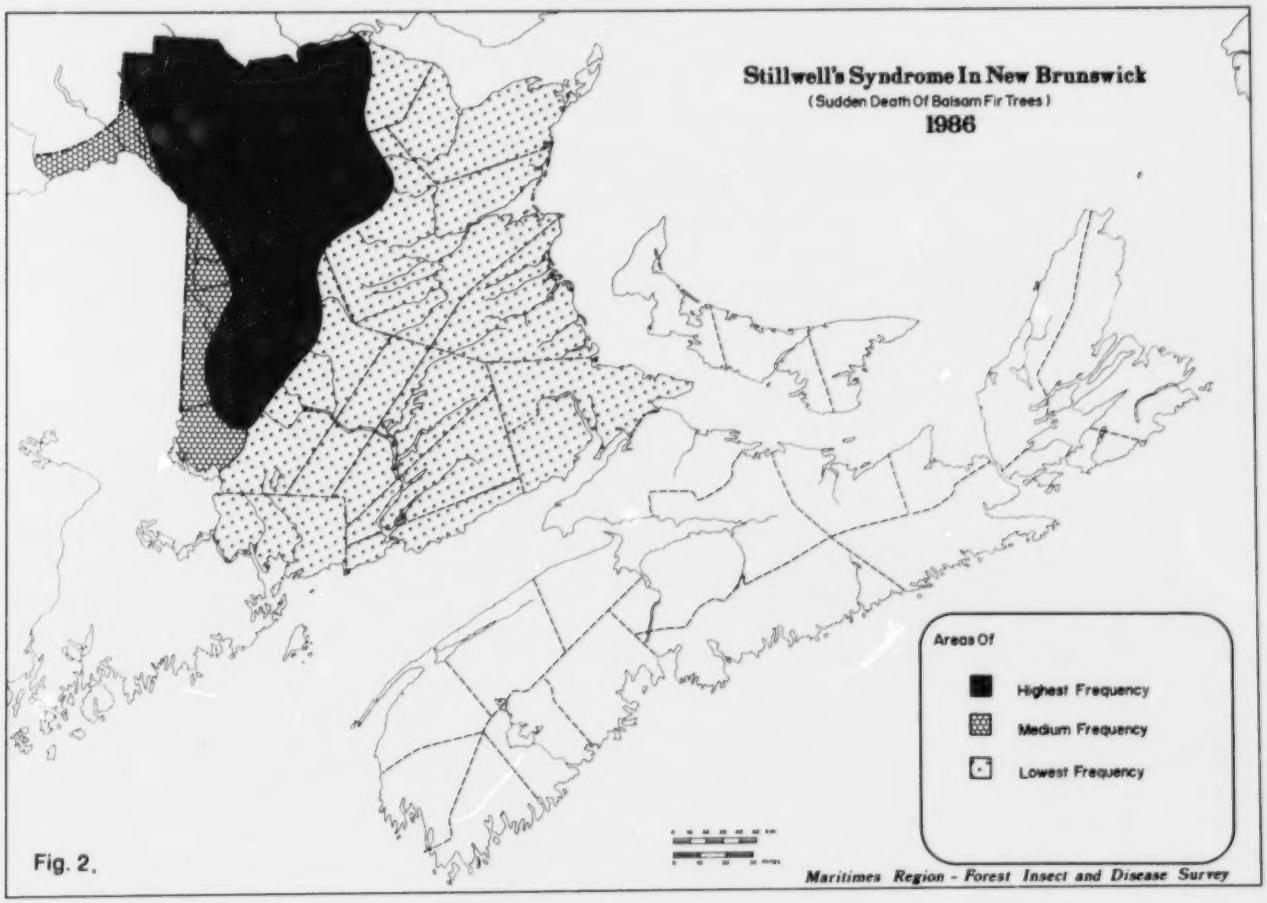


Fig. 2.

Spruce Beetle, *Dendroctonus rufipennis* (Kby.) remained active throughout the Region in 1986 and white spruce mortality occurred in all three provinces. However, the downward trend in populations and in the number of newly attacked trees, reported annually since 1984, continued in most areas.

In New Brunswick, spruce beetle damage was reported in 1980 after a 50-year period of inactivity. Since then, the insect has been found in widely separated areas, mostly in the southeastern and northwestern parts of the Province. In 1986, there was an increase in beetle activity and further tree mortality resulted in Fundy National Park, Albert County and on Grand Manan Island, Charlotte County. In one area along the Whistle Road on Grand Manan Island, only 12% of the mature white spruce trees remain healthy, 52% having been killed by the beetle, while 36% are attacked but still alive. Current infestations have also been observed in Westmorland, Restigouche, and Northumberland counties.

In Nova Scotia, Cape Breton Island constituted the major outbreak area during the early part of the 1980s and by the end of 1983 no large areas remained without severe white spruce mortality. Beetle activity decreased in 1984 and in 1985. In 1986 a further reduction in newly attacked trees was observed although spruce beetle affected trees are still a common sight. More than one-half of the merchantable white spruce volume is now dead on Cape Breton Island as the result of the outbreak. On the mainland, there was an increase in spruce beetle attacked white spruce trees in some parts of Pictou and Antigonish counties in 1986.

In Prince Edward Island, spruce beetle killed an estimated one-third of the merchantable white spruce by 1983 when infestations peaked. Populations have decreased steadily since that time and in 1986 only a few newly infested white spruce trees were observed at six scattered locations in the Province.

Eastern Larch Beetle, *Dendroctonus simplex* Lec., normally attacks only weakened, damaged, or recently felled host material. However, when populations are very high, living, apparently healthy, mature, or overmature trees, and even younger, small diameter trees can also become infested.

In the Maritimes, a population buildup was first noticed in Nova Scotia in 1976. This increase in beetle populations followed several years of severe defoliation of larch by the larch sawfly, *Pristiphora erichsonii* (Htg.). Since then, the beetle has become widespread in all three provinces and has caused serious tree mortality. By the end of 1981, an estimated 24% of merchantable-size larch was dead in New Brunswick, 64% in Nova Scotia, and 13% in Prince Edward Island. The insect populations have been generally declining since 1984 and the number of trees succumbing to beetle attack has also decreased in most areas.

In 1986, newly attacked larch trees were observed in York and Carleton counties in New Brunswick and in a few areas in Prince County, Prince Edward Island.

At the central New Brunswick research plot there was an increase in newly infested trees, in contrast to the general downward trend, as 6.7% of the trees were attacked, compared to 2.8% in 1985, 3.8% in 1984 and 2.9% in 1983. Cumulative larch mortality due to attack by the eastern larch beetle has increased to 34% in 1986, from 6% in 1979, when the plot was established; an average of 4.3% annual tree mortality.

CANKERS OF CONIFERS

Cankers are caused by many fungi, the attacks of which are manifested in different ways. However, all are similar in one important aspect: they damage trees. Damage varies from the loss of a few small branches or minor stem infections to the deformation of the stem to such an extent that it becomes of little or no value, or the tree may die. Damage in stands is also variable. Some canker diseases eliminate only a few trees, while others may spread and infect most or all trees in a stand or plantation. Losses are both direct, such as mortality or reduction in wood value, and indirect, such as low quality trees occupying valuable space, or affected trees serving as sources of infection either to other trees in the same stand or to areas nearby.

European Larch Canker, caused by the fungus *Lachnellula willkommii* (Hartig) Dennis, was first discovered in the Maritimes in 1980. Surveys since then established the distribution of the disease as widespread in southeastern New Brunswick and on mainland Nova Scotia. European larch canker has been a serious disease in many parts of Europe. The fungus is considered, by most, to be a primary pathogen (capable of infecting vigorous, healthy trees) and its presence has resulted in the exclusion of larch from plantation programs in parts of Europe. In North America, the fungus was first found in Massachusetts in the 1920s in European larch plantations. Periodic concentrated eradication attempts appeared to have been successful as the disease was not found during surveys of the area in 1965. However, it was discovered in northeastern Maine in 1981.

The fungus infects mostly young trees, therefore, future wood supplies may be affected. Tree mortality reduces stocking, branch mortality reduces growth, and cankers reduce wood quality. The extent to which the disease will cause damage in the Maritimes is not yet known but the potential for damage is there and the role of the disease will have to be considered in view of increased emphasis on forest renewal and larch tree improvement programs.

In 1986, the disease was found only at one location outside the range of the known distribution, west of Torbay, Guysborough County, Nova Scotia, where one tree was found affected. More than 75 other areas surveyed in unaffected areas of the three provinces in 1986 were negative (Fig. 3).

Investigation of several aspects of the behavior of the fungus under our climatic conditions has been initiated. Results will be reported as they become available. A survey to establish age and spread pattern indicates that the fungus could have been present in the Maritimes for about two decades before its discovery and may have spread from specific areas. The study also showed a rapid decrease in incidence of infected trees with increasing distance from the Bay of Fundy, possibly indicating a climatic dependence (Ostaff, 1985).

The disease is capable of intensifying rapidly in young stands. Based on fall assessments, incidence of infected trees in a research plot increased as follows: 1982 - 7%; 1983 - 19%; 1984 - 46%; 1985 - 88%, and 1986 - 91%.

Greenhouse-grown seedlings of 22 populations of *Larix decidua, L. leptolepis, L. eurolepis, L. laricina,* and *L. sibirica* were successfully planted in a heavily infected area in the early summer of 1983 to test differences in susceptibility to infection. *Larix occidentalis* seedlings were added to the test in 1985. Cankers, bearing fruiting bodies of *Lachnellula willkommii,* were found on three *L. decidua* seedlings in the fall of 1984. By the fall of 1985, 11 of the 24 living larch populations had at least one seedling infected by the disease. The species affected were *L. decidua, L. leptolepis* and our native tamarack, *L. laricina* (Ostaff and Newell, 1986). No new larch populations became infected in 1986, however additional seedlings of already affected populations did show signs of disease.

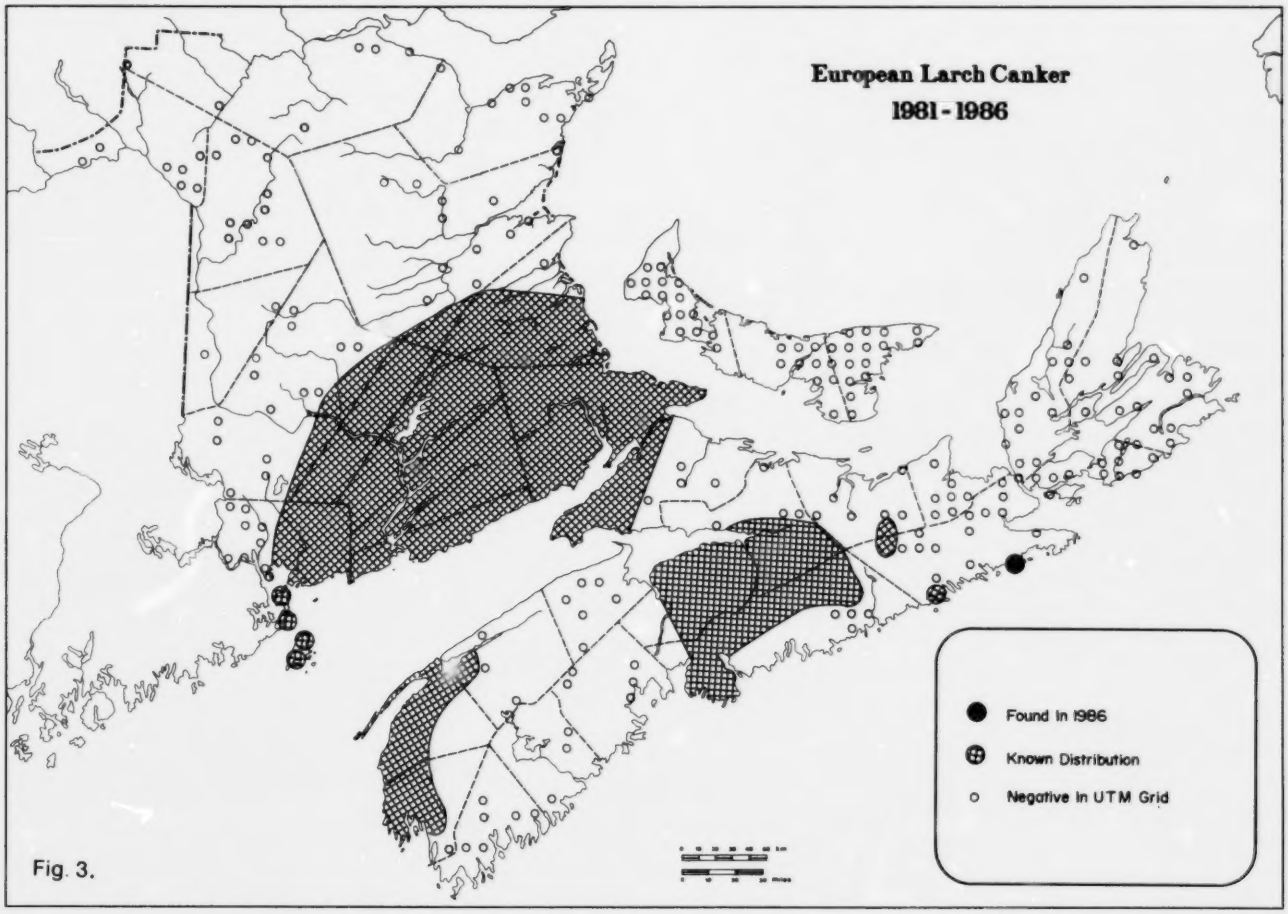


Fig. 3.

Scleroderris canker, caused by the fungus *Gremmeniella abietina* (Lagerb.) Morelet, was first found in the Maritimes Region in 1971. The disease is widespread in New Brunswick, especially in the northern half of the Province and infects mostly plantations of jack, red, and Scots pine. In Nova Scotia, where the disease was first found in 1972, a few plantations of red, jack, and Scots pine suffered limited lower branch mortality during the mid-1970s. The disease was last found in that Province in 1978 and appears to have died out. It has never been found in Prince Edward Island.

In 1986, the disease was found only at one location in New Brunswick, in a red pine plantation near Deersdale, York County, where lower branch infection occurred.

The European race of the disease is capable of killing trees of any size (the North American race kills only small trees). This and several other "intermediate" races, have been found in New Brunswick at 11 locations since 1978. Eradication attempts at a forest nursery, in a Christmas tree plantation and in a commercial plantation appear to have been successful in eliminating the disease. The remaining eight plantations have been under close annual surveillance for changes in symptom expression, which at the current stage of disease development are indistinguishable from those of the North American race. In addition, samples from each area are serologically analyzed for race determination. The fact that none of the samples since 1983 proved to be of the European race gives rise to cautious optimism regarding the future of this race in the Maritimes.

SEEDLING DEBARKING WEEVIL

The Seedling Debarking Weevil, *Hylobius congener* D.T., has been suspected as the causal agent in the mortality of newly planted coniferous seedlings in central Nova Scotia since the beginning of the 1980s. Its association with the problem was first reported in 1984, when seedling mortality exceeded 85% in some plantations. The insect is present on the sites as early as the time of harvest.

Debarking of the stems of seedlings occurs from spring through to fall resulting in progressively increasing seedling mortality. The amount of damage is related to forest management practices, such as 'hot planting', i.e., planting of cutover areas very soon after harvest, site preparation, plantation size, and the proximity of plantations to other harvested areas. The level of concern for this insect is related to increased awareness by forest managers, the recognition of the fact that past unexplained plantation failures may have been the result of weevil damage and the realization that in the absence of practical control methods the future of large-scale plantation programs may be jeopardized.

In 1986, a survey of about 130 areas by the Forest Insect and Disease Survey in cooperation with numerous government and industrial agencies showed that although the most serious damage occurred in eastern mainland Nova Scotia and eastern Prince Edward Island (Fig. 4), considerable damage also occurred elsewhere in the Region. Table 3 illustrates the percentage of plantations by province in the various damage categories.

Table 3. Frequency of plantation in five categories of seedling mortality caused by the seedling debarking weevil in the Maritime Provinces in 1986*

Mortality	Plantations %		
Range (%)	New Brunswick	Nova Scotia	Prince Edward Island
None	73	39	41
1 - 5	20	32	17
6 - 10	7	14	0
11 - 20	0	11	17
21 - 100	0	4	25

*17 negative plantations on Cape Breton Island, N.S., have been omitted from the calculations.

Research, initiated in 1985, continued in 1986 and dealt with determining the life cycle of the insect, as it relates to control, and factors that were indicated as important in

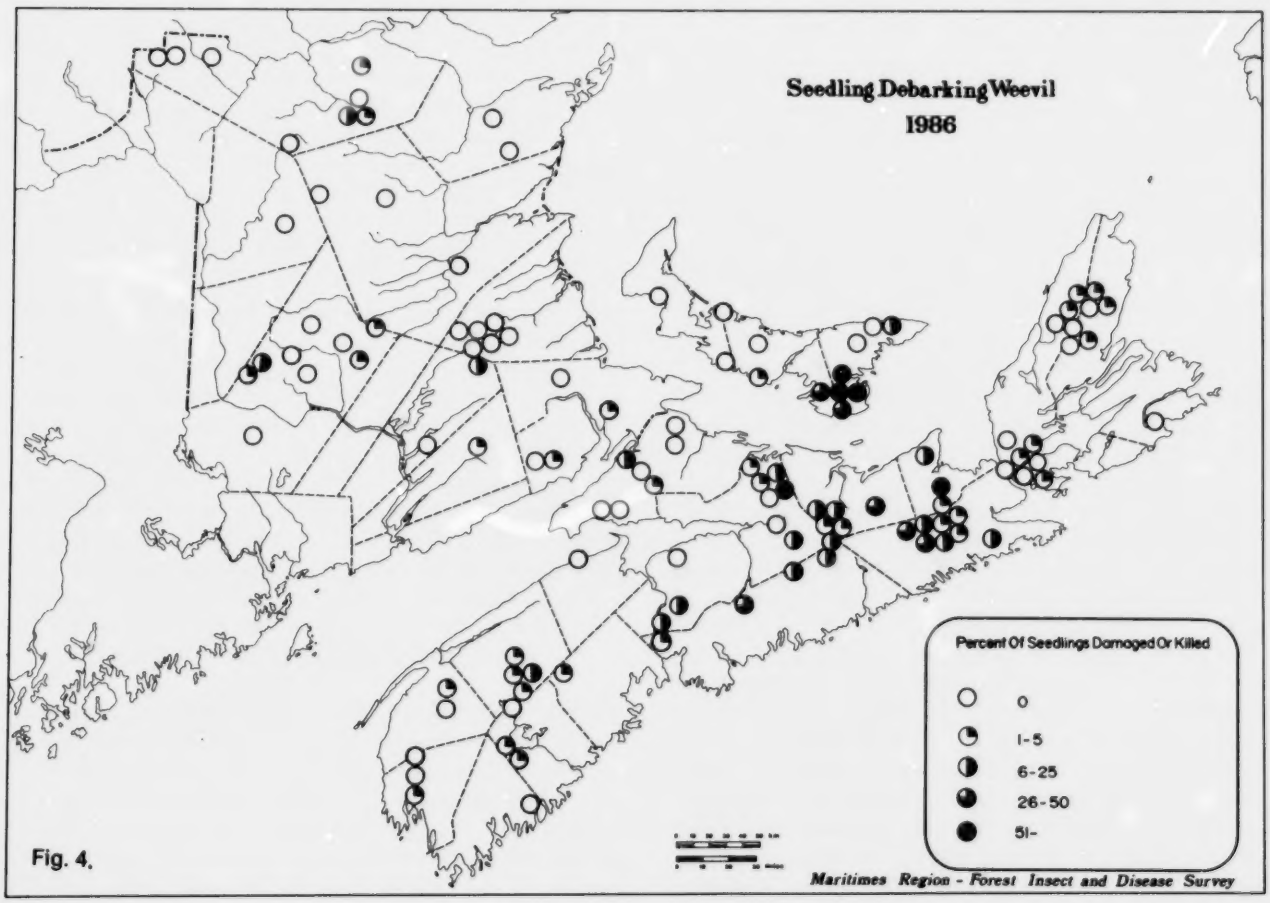


Fig. 4.

the management of the problem, i.e., time elapsed between harvesting and replanting, techniques of site preparation, size of the area planted, silviculture methods applied in surrounding areas. A variety of control tactics, such as insecticides, biological control, physical barriers, site preparation techniques, pheromones and other attractants, and rescheduling planting dates were also investigated. Analysis of research results is under way and the development of a hazard rating system and a management model have been initiated. Some results are expected in advance of the next planting season and will be published.

SIROCOCCUS SHOOT BLIGHT

Sirococcus shoot blight, caused by the fungus *Sirococcus conigenus* (DC) P. Cannon & Minter (previously known as *Sirococcus strobilinus* Preuss), has been known in the Maritimes since the early 1970s but has been present for much longer. The fungus infects and kills newly developed shoots. Fruiting bodies are produced on the twigs, needles, and cone scales from whence the spores disperse and cause new infection. Heavy attacks cause branch mortality, which result in crown dieback and tree mortality. In the Maritimes, the disease affects red pine and occasionally spruce and larch, although other species of pine, hemlock, Douglas fir, and true firs can also be affected. Trees of any size, from seedlings to 15 m in height, are damaged or killed.

The initial infection in newly established plantations appears to be closely related to the proximity of older red pine stands, as 48% of young plantations less than 1 km from older red pine were found infected, compared with 8.7% which were more than 1 km away from an infection source. After the initial infection, the severity of the disease increases as the trees became older (Wall and Simpson, in prep.).

The disease is present in all three provinces but is most widely distributed in red pine plantations in Nova Scotia, west of the Colchester-Pictou and Halifax-Guysborough county lines, and in natural regeneration in the southern half of New Brunswick.

In 1986, the disease further intensified in all three provinces. In many areas the repeated infection has resulted in serious deterioration of red pine stands and plantations, in some to the point that salvage operations were carried out.

In New Brunswick, Sirococcus shoot blight occurs mostly in the southern part of the Province, although affected plantations are known as far north as the line from southern Victoria to northern Kent counties. Infection, in general, was at about the same level as in 1985. Some young red pine trees under older infected trees have died in Charlotte County and at Londonderry, Kings County. A mature red pine plantation, with chronic moderate and severe infection, which had seriously deteriorated was cut in 1986. About 20% of the red pine trees in a mixed area of red pine-jack pine-spruce were infected near a seed orchard at Parkindale, Albert County.

In Nova Scotia, infected red pine stands in Cumberland, Colchester, Hants, and Yarmouth counties continued to deteriorate. The disease increased in intensity at Diligent River, Cumberland County, where it was first found in 1985. Severe shoot browning occurred in a small plantation near Parrsboro, Cumberland County. Several new areas with severe shoot browning were found elsewhere. Infected, deteriorating stands were harvested in the Chignecto Game Sanctuary, Cumberland County, and the stand at Squid Cove, Lunenburg County, reported to have 23% mortality with the rest of the plantation infected in 1985, was also cut. In eastern Nova Scotia, the small red pine plantation in the Perch Lake road area, first reported to be infected in 1985 and surrounded by numerous healthy plantations, was cut in an effort to stop the spread of the disease. Two larch trees at Lochside, Richmond County on Cape Breton Island were found to be infected.

The deterioration of pine stands by this disease in western Nova Scotia and the spread to plantations in the eastern half of the Province, where red pine has been a major plantation species in recent years, makes Sirococcus shoot blight one of the major plantation problems in Nova Scotia.

In Prince Edward Island, Sirococcus shoot blight is now known to be present at three locations: Goose River, Kings County, Iona and Selkirk Road, Queens County. At Iona, where it was first reported on a few red pine trees in a 1-ha plantation in 1984, the number of infected shoots per tree has increased from 'light' to about 60% on some of the fringe trees in 1986. At Goose River, there was a marked increase in shoot infection in a 3-ha, 22-year-old red pine plantation. First reported as light on a few trees in 1985, examination in 1986 showed that virtually all trees have some degree of damage with about 5% of fringe and open growing trees supporting about 50% shoot damage. At Selkirk Road, where the disease was observed for the first time in 1986, about 1-2% of the red pine supported from 5 to 29 damaged shoots on lower crown branches.

SPRUCE BUD MOTH

Spruce Bud Moth, *Zeiraphera canadensis* Mutuura & Freeman, and to a lesser degree, a closely related species, *Zeiraphera unfortunana* Powell, have been omnipresent forest pests in the Maritimes since at least the late 1930s when the Forest Insect and Disease Survey started to keep records. Although widespread, insect populations

have been generally low except for the occasional flare-up, usually on open-grown white spruce. The last recorded outbreak occurred in New Brunswick in the mid-1960s when spruce in parts of the Southwest Miramichi and the Nashwaak River drainage system sustained moderate to severe defoliation, and in Nova Scotia in the mid 1970s when similar levels of defoliation occurred in areas along the Northumberland Strait and the Fundy Coast.

Spruce bud moth, a not-too-important forest insect in mature forests, became a major pest in 1980, when, it was discovered to be causing defoliation, shoot distortion, and tree deformation in white spruce plantations over large areas in New Brunswick. In 1982, over two-thirds of the 180 locations surveyed in the Region were infested by spruce bud moth. At over 40% of these locations, in both New Brunswick and Prince Edward Island, defoliation and shoot damage were in excess of 10%. Injury was classed as moderate or severe at 10 and 20%, respectively, of the locations surveyed.

In 1986, spruce bud moths were widespread in the Region and there was some increase in populations from 1985 levels in some areas as follows:

In New Brunswick, an average of 10% of the shoots of white spruce trees were affected over much of the Province, however, shoot damage as high as 60% was observed in Kouchibouguac National Park in Kent County. All trees were affected in some plantations and none in others but 73% of the trees observed in the Province had at least some damaged shoots. Moderate damage on 20% of the trees was observed in a plantation on the Little Wapske River, Victoria County.

In Nova Scotia, the average number of shoots damaged was 10%. The highest level of damage in the Province was observed at Ben Eoin, Cape Breton County, where 35% of the shoots were affected on 80% of the white spruce trees. Although shoot damage was generally light in the Province, an increase from 1985 levels was noted in some areas.

In Prince Edward Island, there was a marked increase in the population levels of *Z. canadensis* while those of *Z. unfortunana* remained low throughout the Province. Shoot damage at 9 locations averaged about 40%, however in some young white spruce plantations, 70% of the shoots were affected. The most serious damage was observed at Granville and Brookvale, Queens County and at Harmony Road, Prince County.

ARMILLARIA ROOT ROT

Armillaria Root Rot, *Armillaria mellea* (Vahl ex Fr.) Kummer, a disease of a wide variety of tree species of various ages, has always been a part of the forest disease complex in the Maritimes, however, its significance appears to have changed in recent years. On the one hand, the fungus is strongly implicated among the group of secondary organisms that combine to provide the final blow to trees weakened by other factors such as repeated defoliation by the spruce budworm. On the other hand, Armillaria infected or killed trees are becoming more frequent throughout the Maritimes, and are often observed in plantations. The increased frequency is doubtless a factor of the increase in the area planted. The implications of the root rot to the future of plantations under our climate are poorly understood. However, the disease is killing trees in plantations. In some areas, groups of trees are affected and there is evidence that with the spread of the fungus these patches could increase in size. In other areas, only scattered trees are infected but these could become centers of infection if the fungus spreads. Not all infected trees die, (the fungus is primarily a wood decay organism causing root and butt rot), but its action can cause understocking in both plantations and natural stands.

Armillaria root rot is also an important part of the complex of organisms associated with mortality of mature trees that have been stressed by other factors such as repeated moderate or severe defoliation by the spruce budworm. The fungus is also closely associated with Stillwell's Syndrome, the sudden death of balsam fir trees (see p. 8).

The disease is widely distributed in the Region and mortality of trees, both young and old, was again common in 1986. In New Brunswick, Armillaria root rot killed at least some trees in 22% of the 141 spruce and pine plantations surveyed during the province-wide assessments. This represents 6% increase over the 16% incidence found in 1985, based on similar surveys in 70 plantations. The disease is present in all areas of the Province and affects both spruce and pine. There are differences in the rate of infection among the five regions and also between the level to which the two species are affected (Table 4). Whether the differences are real or merely differences in expertise among the observers remains to be seen but the fact that the disease is present is inescapable and is cause for concern. Tree mortality in the affected plantations, attributable to Armillaria root rot ranged from 2 to 8%. In Nova Scotia, the disease affected 12% of Norway spruce trees in a provenance trial north of Trafalgar, Pictou County, 3.3% of red spruce seedlings in a 200-ha plantation north of Mount Thom, Pictou County, and was found in a seed orchard at Debert, Colchester County. In Prince Edward Island, two young (1 m in height) larch trees were killed in a demonstration woodlot near Valleyfield, Kings County.

Table 4. Armillaria root rot in spruce and pine plantations in various areas of New Brunswick in 1986

		DNRE Resource Management Region				
		1	2	3	4	5
Number of plantations assessed	Spruce	15	5	17	7	51
	Pine	10	6	16	7	5
Percent of infected plantations	Spruce	6	20	12	14	41
	Pine	22	-	-	14	25

Plots established in plantations to study the spread of the disease on different hosts and under different conditions have been assessed annually since 1983. The plantations are of different ages and were established in areas of somewhat different cover types. Subplots, comprised of the 10 trees nearest all infected trees have also been evaluated. The summary of observations is presented in Table 5. No changes occurred on the plots in 1986 but there was minor intensification of the disease on a few of the subplots. Trees in older plantations are said to acquire some resistance to fatal attack by Armillaria root rot, which they retain as long as they are in a vigorous stage without significant stress. Some of our study plantations are reaching this age, and all of them were free of weather- or pest-related stress during the 1986 growing season. More plots of various species and especially of younger ages are to be established to assess the real significance of this disease in plantations.

RUSTS ON CONES, NEEDLES AND LEAVES

Cones and needles of conifers are infected by a group of rust fungi. Cone rusts, because of their potential to interfere with seed production, are among those forest diseases that may have a direct impact on all aspects of forestry in both the short and long term. Needle rusts cause the infected needles to fall off the tree prematurely and, when infection levels are high, damage occurs, such as reduced grade for Christmas trees, growth loss, or in case of repeated severe defoliation, death of young trees in plantations.

Table 5. Armillaria root rot - spread of disease in plantations 1983-1986

				Mortality, %				No.of subplots and percent mortality by year							
								1983		1984		1985		1986	
Species	Year planted	Year plot est.	Former cover type	1983	1984	1985	1986	No.	%	No.	%	No.	%	No.	%
Black spruce	1976	1983	Softwood	8	10	10	10	4	17	5	16	5	16	5	16
Black spruce	1973	1983	Softwood-Hardwood	4	4	4	4	2	5	2	10	2	15	2	15
Black spruce	1978	1983	Softwood-Hardwood	8	12	20	20	5	4	8	6	10	6	10	10
Black spruce	1980	1983	Softwood-Hardwood	8	16	24	24	4	10	8	22	12	30	12	30
Jack pine	1978	1984	Softwood-Hardwood	-	2	2	2	-	-	0	-	1	0	1	0
Jack pine	1981	1984	Softwood-Hardwood	-	2	4	4	-	-	2	0	2	0	2	5
Jack pine	1978	1984	Softwood-Hardwood	-	2	2	2	-	-	0	-	1	10	1	10
Black spruce	1980	1985	Softwood-Hardwood	-	-	2	2	-	-	-	-	1	20	1	40

Most of the rust fungi need two different hosts to complete their life cycle. The alternate host is often a herbaceous or woody plant which occurs in close association with the coniferous host, frequently in the same plantation. Rusts on the conifers are similar in appearance but because each species needs a different alternate host, the proper identification of the fungus is important if control measures are anticipated.

On hardwoods the situation is similar to that on conifers. Heavy infection causes foliage discoloration and the leaves fall prematurely. Repeated heavy attacks result in twig and branch dieback and may eventually kill the tree. Many of the leaf rusts, such as those found on poplars and willows, are stages of the same species alternating between these trees and various conifers. Control in these situations, where both hosts are of value, become complicated and care must be taken in species selection for uses such as in windbreaks around nurseries, seed orchard or ornamental settings.

The various rusts encountered in 1986 are discussed by host tree species below:

Coniferous hosts:

On Balsam fir - Needle rusts found on balsam fir in 1986 include *Melampsora abieti-capraearum* Tub. (alternate host: willow), *Pucciniastrum epilobii* Otth (alternate host: fireweed), *Pucciniastrum goeppertianum* (Kuehn) Kleb. (alternate host: blueberry), and *Uredinopsis* sp. (alternate hosts: ferns). They were present alone or in various combinations throughout the Region but infections were generally low and rarely exceeded 5% of the needles affected. The most serious infection reported occurred on cutover areas north of Mullin Stream, Northumberland County, New Brunswick where an average of 56% of the new needles were affected on 90% of the young natural regeneration in a 5-ha area.

On Hemlock - *Pucciniastrum vaccinii* (Wint.) Jorst. (alternate host: blueberry) caused light infection at Kejimkujik National Park, Annapolis County, Nova Scotia.

On Larch - *Melampsora medusae* Thuem. (alternate host: poplars) caused very light yellowing on about 5% of the needles at several locations in Prince Edward Island and also affected leaves of trembling aspen and largetooth aspen. The rust was also found at one location in New Brunswick.

On Pine - *Coleosporium asterum* (Diet.) Syd. (alternate host: goldenrod) and *Coleosporium viburni* Arth. (alternate host: *Viburnum* sp., wild raisin, hobblebush, highbush, cranberry, etc.) were the two species of needle rusts encountered on pine in 1986. While *C. viburni* appears mostly on jack pine *C. asterum* affects both jack pine and red pine and the two species may occur together when the respective alternate hosts are present. Because field identification on jack pine is impossible and because numerous reports, especially from plantation surveys, are not supported by samples for laboratory identification, these rusts are discussed together.

In New Brunswick, *C. viburni* has been by far the most important needle rust encountered in recent years. Repeated severe infection and the needle drop that follows resulted in young plantation trees being sustained by their current foliage only in a number of areas in the southern half of the Province. Infection levels are closely correlated to the abundance of the alternate host and the distance of trees from it. Smaller trees are more seriously affected. In 1986, needle rust was still common but infection rates were lower than in previous years. The results of plantation surveys showed that more than half (52%) of the jack pine plantations assessed were affected by needle rust in New Brunswick in 1986. The disease was most common in DNRE region 3 in the southeastern part of the Province where the rust was found in 83% of the plantations assessed. Needle rust was common in infected plantations as 58% of the trees assessed supported the fungus but the level of infection was only a trace on 42%, light on 7%, moderate on 8% and severe on 1% of the affected trees (Table 6). Severe infection occurred in three plantations, all in the southeastern part of the Province, but even in these no more than 12% of the trees assessed supported this level of infection.

In Nova Scotia, needle rusts were common on pine but generally little infection was observed. The highest infection occurred in a jack pine plantation southwest of Shulie, Cumberland County, where 54% of the older needles were affected.

In Prince Edward Island, a few scattered red pine plantations were affected but not more than 5% of the needles were infected. The most serious needle rust infection occurred in a 7-year-old, 6.5-ha jack pine plantation at Goose River, Kings County, where 60% of the older needles turned yellow and all trees in the plantation were damaged.

Research was initiated in response to the concern over the effect of needle rust on the condition of jack pine plantations in New Brunswick. Objectives are to determine the relationship between infection levels and volume increment reduction towards the establishment of threshold levels for control, and to determine the seasonal occurrence of various spore types with special reference to the time period when pine is infected, and control of the rust. Early results are expected during 1987 and will be disseminated when available.

Table 6. Needle rust in infected jack pine plantations in New Brunswick - 1986

NBDNR&E Region	Plantations assessed No.	Plantations affected %	Trees infected in plantations %	Trees in various infection categories, %				
				Negative 0	Trace 1-5	Light 6-29	Moderate 30-70	Severe 71-100
1	9	44	40	60	39	0.3	0.7	0
2	6	43	20	80	19	0.5	0.5	0
3	16	81	83	17	54	13	14	2
4	7	43	43	57	34	4	5	0
5	4	50	34	66	34	0	0	0
N.B.	42	52	58	42	42	7	8	1

On Spruce - *Chrysomyxa ledi* dBy. and *Chrysomyxa ledicola* Lagerh. (alternate host for both: Labrador tea) were found widespread but mostly at very low levels on black spruce, white spruce, red spruce throughout much of the Region. The only exception was in a white spruce plantation at Goose River, Kings County, Prince Edward Island where 20% of the trees had 30% of the needles infected by *C. ledi*. The results of plantation surveys in New Brunswick showed that about 12% of spruce plantations assessed were affected by needle rust in New Brunswick in 1986. Among the 21 infected plantations, 16 were white spruce, 2 black spruce, 1 Norway spruce, 1 hybrid spruce and 1 a mixture of white and black spruce. All plantations from which samples were submitted were affected by *C. ledi*. The disease was found in two of the five DNRE regions and was most common in region 5 (31% of plantations assessed) and region 3 (29%). In infected plantations, the rust was present on 60% of the trees but the level of infection was only a trace on 55%, light on 4% and moderate on less than 1% (0.5%) of the affected trees (Table 7). Moderate infection occurred in a hybrid spruce plantation at Marrtown, Kings County on 8% of the trees and in a Norway spruce plantation at Dubee Settlement, Kings County on 3% of the trees assessed.

Pucciniastrum americanum (Farl.) Arth., the cone rust on white spruce (alternate host: raspberry) which caused severe infection in New Brunswick in 1984 was largely absent in 1986, as in 1985. Infected cones were found only in Cape Breton Highlands National Park, Nova Scotia (2 cones) and the fungus was present in a seed orchard at East Mines, Colchester County, Nova Scotia.

Results of a study on the effect of infection on seed quantity and quality indicate that while light infection had no apparent effect on either the total number of seeds per cone or the percentage of sound seed, moderately affected cones produced fewer seeds and fewer of these seeds were sound than in healthy cones. When infection was heavy the seeds were totally destroyed (Smith *et al.* 1986).

Chrysomyxa pirolata Wint., another cone rust of spruces, (alternate host: *Pyrola* sp.) was found in one black spruce plantation in Madawaska County, New Brunswick.

Hardwood hosts:

On Ash - the ash rust, *Puccinia sparganioides* Ell. & Barth., (alternate host: cord grass (*Spartina* sp.)) has been one of the most serious foliage problems on ash in many parts of western Nova Scotia for the past decade. Infection causes foliage discoloration and premature leaf fall. Repeated attacks cause dieback and in some cases tree mortality. In 1986, the chronic leaf discoloration was present again in many locations although infection levels appeared somewhat reduced from previous years. Twig and branch mortality continued and in Hantsport, Hants County, many ash trees failed to produce a full complement of foliage in the spring and a few shade trees were dead. Some trees were cut. In eastern Nova Scotia, the disease was observed in Colchester, Pictou, and Antigonish counties. In most areas foliage discoloration was light except at MacBain's Corner, Colchester County where, although 65% of the leaves were affected, only a small proportion of the leaf surface turned color. The disease was found only at one location in New Brunswick and was not found in Prince Edward Island.

On Poplar - *Melampsora medusae* Thuem. - see under larch.

Table 7. Needle rust in infected spruce plantations in New Brunswick - 1986

NBDNR&E Region	Plantations assessed No.	Plantations affected %	Trees infected in plantations %	Trees in various infection categories, %				
				Negative 0	Trace 1-5	Light 6-29	Moderate 30-70	Severe 71-100
1	15	0	-	-	-	-	-	-
2	5	0	-	-	-	-	-	-
3	17	29	45	55	32	11	2	0
4	7	0	-	-	-	-	-	-
5	51	31	65	35	63	2	0	0
N.B.	95	12	60	40	55	4	<1	0

GYPSY MOTH

After its reappearance in the Maritimes in 1981, the gypsy moth, *Lymantria dispar* (L.), gained further ground in 1986, and is now at least temporarily established in both New Brunswick and Nova Scotia.

Gypsy moth has been the most destructive insect of hardwoods and to a lesser degree of conifers in the northeastern United States for decades. The status of the outbreak in Maine in the last few years has been a special concern to us because of its proximity to our Region.

The gypsy moth monitoring committee remained active in 1986, and again coordinated all surveys. This committee was formed in response to the discovery of gypsy moth in 1981. The objective was to utilize available manpower more efficiently in combating this latest threat to the forests of the Region. Organizations involved in surveys included the Forest Insect and Disease Survey of the Canadian Forestry Service, Parks Canada of the federal Department of Environment, the Plant Health and Inspection Branch of Agriculture Canada, New Brunswick Department of Natural Resources and Energy, New Brunswick Department of Agriculture, New Brunswick Department of Tourism, Recreation and Heritage, Nova Scotia Department of Lands and Forests, Nova Scotia Department of Agriculture, Prince Edward Island Department of Energy and Forestry, and numerous municipalities. Many volunteers, campground operators, small woodlot owners, Christmas tree growers, students, and other interested private citizens also assisted in the pheromone trapping program.

In 1986, early season egg-mass surveys, larval surveys, adult trapping program and late-fall egg-mass surveys were conducted to determine the current status of the insect in the Region.

The adult male trapping program is aimed at defining areas where searching for egg masses should be concentrated. As a result of studies since 1980, the trap placement design was changed in 1983 to eliminate, or at least to minimize, interference from large numbers of male moths brought into the Region by weather fronts from infested areas in the United States. Information was obtained from 2869 traps, 1489 in New Brunswick, 1104 in Nova Scotia, and 276 in Prince Edward Island. Better understanding by cooperators of the value of negative results greatly aided the planning of the fall egg-mass surveys.

The status of the gypsy moth in the Maritimes in 1986 was as follows:

In New Brunswick, gypsy moth egg masses and/or pupae were found at 13 locations in Charlotte and southern York counties and in Fredericton in central York County. In Charlotte County, gypsy moth has been found previously at six of the 10 positive locations. The new locations, Baillie Settlement, Anderson Settlement, Pleasant Ridge, and Moores Mills represent a northeastern spread of gypsy moth from the previously affected areas. In York County, the two new locations, McAdam and Woukichegan Lake, represent an inward extension which apparently coincides with the northward extension of the gypsy moth in the state of Maine (pers. comm., Maine Forest Service). The number of egg masses are low in all areas and no noticeable defoliation occurred anywhere in the Province. The suspect area near Peel, Carleton County was searched thoroughly and subjected to an extensive pheromone trapping program but no sign of gypsy moth (except for a small number of male moths) was found in 1986.

In Nova Scotia, gypsy moth was found at 11 locations in eight of the nine counties in the western half of the Province. All but one of the areas were either the same or adjacent to areas where the insect had been found in

previous years. The exception was Canadian Forces Base Greenwood, Kings County. This find represents a minor extension in distribution. In addition to CFB Greenwood, egg masses were also found at two other Canadian Forces Bases, at CFB Shelburne and at CFB Cornwallis, both immediately adjacent to previously known infestations. An egg mass found for the first time in Queens County, in Kejimkujik National Park, was close to an area near the county line where gypsy moth was found previously. Egg masses were not numerous in most areas, except at New Minas, Bridgewater, and Shelburne but even there noticeable defoliation did not occur in 1986. It is worth noting that, in spite of extensive searching, gypsy moth was not found in several areas, particularly Yarmouth, where egg masses were present in previous years.

In Prince Edward Island, the gypsy moth is not known to occur to date.

The results of gypsy moth surveys, other than adult trapping programs, conducted from 1981 to 1986 are summarized in Tables 8 and 9 and in Figure 5. In New Brunswick, most of the gypsy moth locations are in forested areas, away from habitation and are concentrated in a small section of the Province adjacent to an area of the United States where the insect is known to be present. In Nova Scotia, almost all of the infested spots are inhabited areas with considerable movement of people. This suggests that while in New Brunswick the presence of gypsy moth, in most places, may be the result of natural spread, in Nova Scotia the insect was likely

Table 8. Summary of the results of detection surveys for gypsy moth in New Brunswick 1981 - 1986

			Gypsy moth found[2]					
County	Location	UTM Grid[1]	1981	1982	1983	1984	1985	1986
Carleton	Peel	19-61-513					●	-
Charlotte	Mohannes	19-62-500	●	●	●	●	●	●
	N.W. of Oak Hill (Canoose Rd)	19-62-502			●	●	-	-
	Oak Hill	19-63-502		●	●	●	●	●
	Upper Mills	19-63-500			●	-	-	-
	Lynnfield	19-63-502		●	-	-	-	●
	St. Stephen	19-63-500			●	●	●	-
	Oak Bay area	19-64-501			●	-	-	-
	St. Andrews	19-65-499			●	●	●	●
	Didgequash	19-66-500		●	-	-	-	-
	St. George	19-67-499		●	●	●	-	-
	Beaver Harbour	19-67-499	●	-	●	-	-	-
	Pennfield	19-68-499	●	-	-	-	-	-
	Campobello Island	19-66-497		●	-	-	-	-
	Grand Manan Island	19-67-494	●	-	-	-	-	-
	Burnt Hill	19-63-500				●	-	-
	Old Ridge	19-63-500					●	-
	Bayside	19-64-500					●	●
	Little Ridge	19-62-500					●	●
	Grand Falls Dam	19-61-501					●	-
	Basswood Ridge	19-62-501					●	-
	Moores Mills	19-63-501						●
	Pleasant Ridge N.W.	19-65-503						●
	Anderson Settlement	19-63-503						●
	Baillie Settlement	19-63-502						●
St. John	Saint John	19-72-501		●	-	-	-	-
York	Forest City	19-59-505					●	-
	Fredericton	19-68-509			●	●	●	●
	St. Croix	19-62-504					●	-
	MacAdam	19-63-505						●
	Woukichegan Lake	19-62-505						●

[1]U.T.M. Universal Transverse Mercator System.
[2]Life stages other than adults (i.e. larva, pupa, egg mass).
● - Gypsy moth found; - gypsy moth not found.

Table 9. Summary of the results of detection surveys for gypsy moth in Nova Scotia 1981 - 1986

County	Location	UTM Grid	Gypsy moth found					
			1981	1982	1983	1984	1985	1986
Yarmouth	Yarmouth	20-24-485	●	●	●	-	●	-
	Tusket	20-26-486			●	●	●	-
Digby	Grosses Coques	20-25-491		●	●	-	-	-
	Digby	20-28-494			●	-	-	-
	Smiths Cove	20-28-494		●	-	-	-	-
	Weymouth	20-26-492				●	●	●
	Weymouth Falls & Tusket Road	20-26-492				●	●	-
	Bear River	20-28-493					●	-
Annapolis	Clementsport	20-29-494		●	-	●	●	-
	Paradise	20-32-497		●	●	-	-	-
	Middleton	20-33-497				●	●	-
	CFB Cornwallis	20-29-494						●
	Annapolis Royal	20-30-495					●	●
	Kejimkujik Nat. Pk.	20-3l-492			●	-	-	-
Queens	Kejimkujik Nat. Pk.	20-32-491						●
Kings	New Minas	20-38-499			●	●	●	●
	Port Williams	20-38-499					●	●
	CFB Greenwood	20-34-498						●
Halifax	Halifax	20-45-494			●	●	●	●
	Dartmouth	20-45-494				●	●	-
Shelburne	Shelburne	20-31-484			●	●	●	●
	CFB Shelburne	20-30-483						●
	Clyde River	20-[illegible]-483			●	-	-	-
Lunenburg	Bridgewater	20-37-491					●	●
Hants	Windsor	20-41-498					●	●

[1]U.T.M. Universal Transverse Mercator System.
[2]Life stages other than adults (i.e. larva, pupa, egg mass).
● - Gypsy moth found; - Gypsy moth not found.

imported by tourists or residents travelling in gypsy moth infested areas.

Control operations against the gypsy moth in 1986 included a mass trapping program in Fredericton, N.B., involving about 650 traps in the infested part of the city, accompanied by searching and destruction of egg masses. Egg mass destruction is carried out routinely during surveys, for the detection or control, except in the Mohannes area in Charlotte County, N. B., where egg masses are used in a parasite recovery study. Many communities are involved in public awareness programs emphasizing citizen participation in combatting this newly arrived pest.

FOREST TENT CATERPILLAR

The forest tent caterpillar, *Malacosoma disstria* Hbn., the major defoliator of hardwoods in the Maritimes since the late 1970s has been on the decline in the past few years, and except for a small area in eastern Nova Scotia, is considered to have ceased to be a major forest pest for the present (Fig. 6).

The outbreak ended in New Brunswick and Prince Edward Island in 1985 and the area of moderate or severe defoliation was drastically reduced in Nova Scotia (Table 10). The insect feeds on a wide variety of hardwood trees with preference for trembling aspen, oak, apple, birch, and cherry. When populations are high and larvae migrate in search of food, other tree species such as sugar maple,

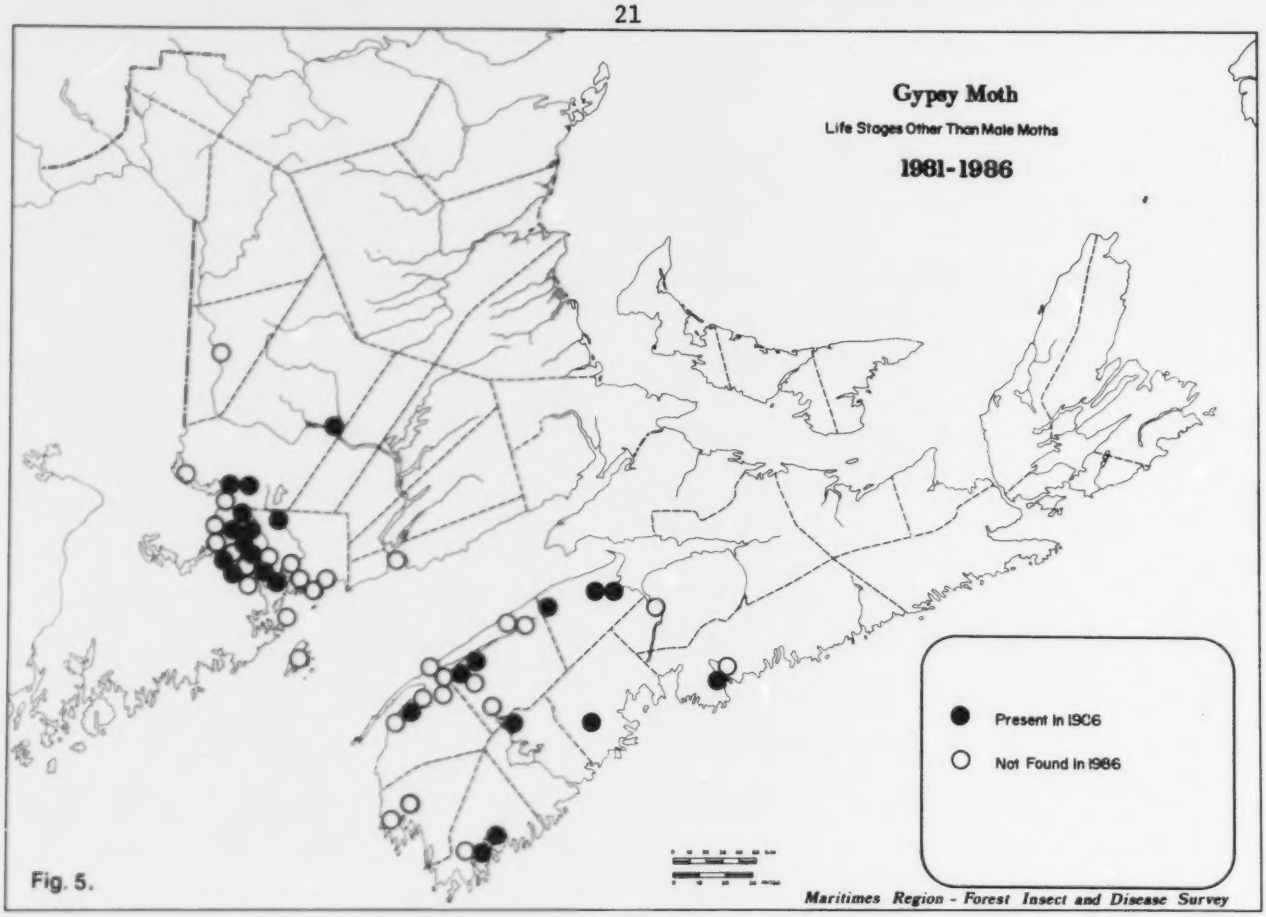

Gypsy Moth
Life Stages Other Than Male Moths
1981-1986
Present in 1986
Not Found in 1986
Maritimes Region - Forest Insect and Disease Survey

Fig. 5.

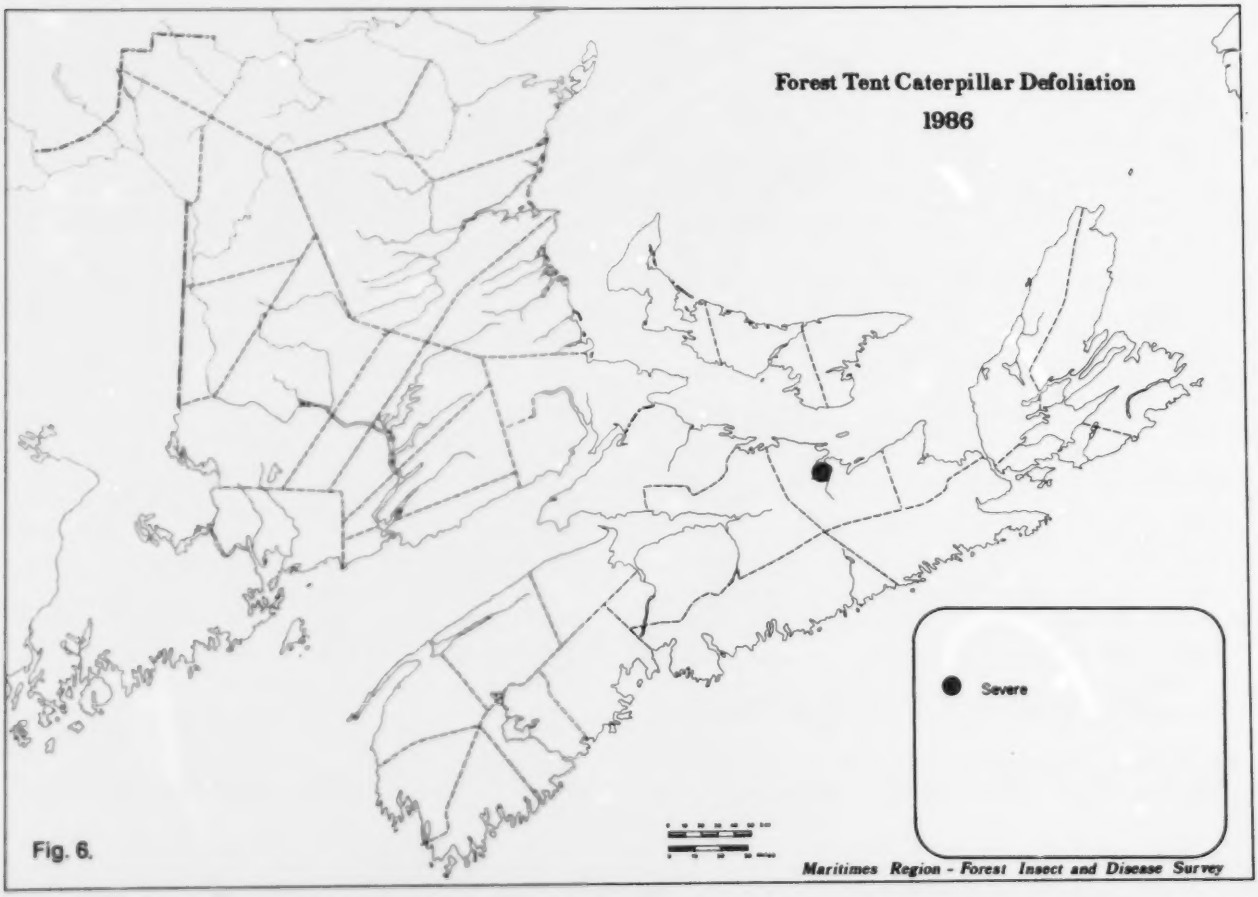

Forest Tent Caterpillar Defoliation
1986
Severe
Maritimes Region - Forest Insect and Disease Survey

Fig. 6.

ash, alder, elm, and ground vegetation are also readily defoliated. Feeding also occurs on some conifers, notably larch and white spruce.

Table 10. Forest tent caterpillar outbreaks in the Maritimes Region (1978 - 1986)

Year	Areas of severe/moderate defoliation (ha)		
	N.B.	N.S.	P.E.I.
1978	patches	-	5 000
1979	37 000	-	5 000
1980	177 000	trace	3 100
1981	775 000	patches	13 800
1982	1 389 000	4 700	18 800
1983	1 119 000	35 000	67 000
1984	94 400	46 400	37 400
1985	-	patches	-
1986	-	patches	-

In New Brunswick, no noticeable defoliation occurred in 1985 for the first time since 1978 - a total collapse - and none was observed in 1986. The outbreak began in 1978 near Woodstock, Carleton County, and by 1982 covered much of the southern half of New Brunswick. In 1984, a dramatic reduction in insect population occurred. Factors which contributed to this collapse included a build-up of disease, parasites, and predators such as the *Sarcophaga* flesh fly, mass starvation of larvae, and unfavorable spring weather conditions.

In Nova Scotia, forest tent caterpillar, in combination with the **large aspen tortrix** *Choristoneura conflictana,* (Wlk.) caused severe defoliation over about 200 ha near Granton, Pictou County, on the eastern mainland. The outbreak in western Nova Scotia, which caused moderate and severe defoliation in patches in Hants, Kings, and Annapolis counties in 1985, collapsed and no defoliation occurred there or anywhere else in the Province in 1986.

In Prince Edward Island, the outbreak which persisted in Prince County since 1973 collapsed in 1985 and no defoliation occurred in 1986.

Fall egg-mass surveys, the results of the pheromone trapping program, and light trap catches all indicate that forest tent caterpillar populations will be practically non-existent in 1987, and no defoliation by this insect is expected anywhere in the Region.

OTHER HARDWOOD DEFOLIATORS

In addition to the gypsy moth, which is of special concern because of its recent arrival in the Maritimes, and the forest tent caterpillar, many other hardwood insects were active in 1986. Most are listed under other insects and diseases towards the end of this report because they occur only in localized areas. However, a few of the more prevalent species are discussed here in some detail. Hardwood defoliators may be host specific or feed on a variety of tree species. Several different insects may attack the same trees at a given location, and often it is difficult and impractical to allocate portions of the total defoliation to the various foliage feeders.

In 1986, hardwood insects, with few exceptions, were noted more for their lack of damage than for having caused significant defoliation over large areas.

Fall Cankerworm, *Alsophila pometaria* (Harr.), was the most prevalent hardwood defoliator, feeding mostly on maple and oak. Defoliation occurred on many patches of various sizes and at various levels of intensity over about 23 000 ha in western Nova Scotia. Most of the defoliation occurred in Yarmouth and Shelburne counties but Halifax, Lunenburg, Queens, and Digby counties were also affected. The insect was also observed in several areas in eastern Nova Scotia, the most serious being moderate defoliation on 40 ha of red maple near Kemptown, Colchester County.

In Prince Edward Island, up to 70% defoliation of red maple and yellow birch occurred for the second consecutive year over 100 ha near Newtown Cross, Queens County. New infestations were recorded near Heatherdale, Queens County (about 250 ha) and at Devon, Kings County (about 100 ha). In each of these areas, defoliation was 70% of red maple and 20% of sugar maple. Fall cankerworm was also found at several other locations where it caused defoliation of Manitoba maple, linden, and elm, mostly in shade tree situations.

In New Brunswick, only trace to light defoliation occurred on a variety of hosts in Restigouche, Gloucester, York, Sunbury, and Kings counties.

Oak Leaf Shredder, *Croesia semipurpurana* (Kft.), and the **Oak Leafroller,** *Pseudexentera cressoniana* (Clem.), have been defoliating oak since the early 1970s and have been the most serious pests of oak in the Maritimes. As a result of repeated defoliation, oak trees in many areas are suffering from various degrees of twig, branch, and crown dieback. Insect populations started declining in 1983, the decline continued in 1984 but the insects still caused various amounts of defoliation of oak in 1985 throughout the Region.

In 1986, the insects, predominantly the oak leafroller were again present in western Nova Scotia and caused an average of 50% defoliation on the permanent study plots

(range 33 to 72%) in Lunenburg and Queens counties. This level of defoliation is considerably higher than observed in 1985 but is similar to defoliation levels in the early 1980s. Defoliation of oak ranged from 25 to 75% in Kejimkujik National Park. Neither insect was found in eastern Nova Scotia.

In Prince Edward Island, 90% defoliation of oak trees, mostly by the oak leafroller, in an area less than 1 ha, occurred at North Milton, Queens County. This constitutes the only observation from the Province.

In New Brunswick, populations were low and defoliation negligible in 1986, except at the Cranberry Lake study area, Queens County, where 25 to 50% defoliation was recorded.

Lesser Maple Spanworm, *Itame pustularia* (Gn.), is a defoliator of red maple. This insect in combination with other foliage feeders and the maple leafroller caused considerable crown dieback and some tree mortality in parts of Northumberland County, New Brunswick during the 1972-1975 infestation. After seven years of very low populations, the insect was found widespread in New Brunswick in 1983 but caused only a trace of defoliation. Population levels increased further in 1984, especially in the eastern part of the Province, and light defoliation (6-19%) occurred at many locations. In 1985, moderate defoliation occurred in parts of Kent and Queens counties and defoliation was light in areas of Gloucester, Northumberland, Westmorland, and Albert counties. Light trap records indicate that the population peaked in 1984 and a downward trend is apparent as illustrated by catches at Ashton Hill, Northumberland County.

1978 - 27	1983 - 9926
1979 - 44	1984 - 32597
1980 - 157	1985 - 782
1981 - 723	1986 - 2
1982 - 1009	

CASEBEARERS, LEAFMINERS, AND SKELETONIZERS

Some insects of specialized feeding habits which do not consume leaves and needles in the manner typical of defoliators are discussed in this chapter.

Casebearers spend their lives hidden in cigar-shaped cases, built of leaf or needle material, attached to the leaf surface. They reach out to feed only as far as the protection of the case allows. When the edible portion of the leaf is consumed the insect moves, house and all, to a new spot to feed. Consequently, feeding by casebearers initially appears patchy. Later in the season, if populations high, the patches join and the foliage becomes discolored.

Leafminers live hidden between the upper and lower protective layers of the leaf and feed on the green inner portion. In the process, the leaf becomes discolored. The extent of discoloration depends on the amount of the green tissue consumed. Some species consume much of the leaf, others cut off water supply to unconsumed portions of the leaf which then turn brown. Still others travel in a characteristic fashion within the leaf, in a pattern typical of the insect species.

Skeletonizers feed on the surface of leaves, usually on the underside, leaving the veins and the upper surface intact. Damaged tissue turns brown from exposure to air and lack of water and the leaves appear scorched. Heavily skeletonized leaves dry up and fall prematurely thus the feeding by these insects results in defoliation.

ON BIRCH

Birch Casebearer, *Coleophora serratella* (L.), is an introduced insect, first reported from Maine in 1927, now widespread throughout the Maritimes. Its preferred host is white birch but other species of birch and alder are also affected. At low populations, the insect causes leaf spotting and foliage discoloration and is merely an aesthetic inconvenience. However, when populations are high, the discoloration becomes serious and repeated attacks by the insect cause decline in vigor, loss of growth, and death of young trees.

In 1986, birch casebearer in New Brunswick caused moderate leaf browning of white birch in northeastern Northumberland, eastern Gloucester, and Albert counties, light foliage discoloration in Kouchibouguac National Park, Kent County and was present at low populations without having a noticeable effect at various locations in the remainder of the eastern part of the Province.

In Nova Scotia, the insect caused moderate foliage discoloration in northern Cumberland and southwestern Yarmouth counties, light leaf browning in other areas in the western half of the Province. It was also present at scattered locations throughout eastern Nova Scotia and caused discoloration of various intensities.

In Prince Edward Island, the infestations, reported in previous years, continued. Up to 80% of the foliage of many clumps of alder, white birch, and wire birch was affected northwest of Miscouche, Prince County. Both insect populations and foliage discoloration were reduced from 1985 levels in much of Queens and Kings counties. They were highest, at about 50% of foliage of alder and young birch affected, at Southampton and Wood Islands, Kings County. Foliage browning was negligible elsewhere in the Province.

Birch Leafminer, *Fenusa pusilla* (Lep.), an introduced insect first observed in 1923 in Connecticut, has spread throughout Canada and now is found from Newfoundland to Alberta. The birch leafminer is a perennial pest in the Maritimes, it prefers wire birch but is also commonly found on white birch.

In 1986, the birch leafminer was again present throughout the Region, mostly on its preferred host, wire birch, but at populations much reduced from 1985 levels, especially in New Brunswick. Although the degree of leaf browning was variable it usually remained trace or light.

Birch Skeletonizer, *Bucculatrix canadensisella* Cham., outbreaks occur periodically in the Maritimes. The insect prefers white birch but other species of birch are also subject to attack. An outbreak, reported in 1977, covered extensive areas in Nova Scotia and eastern Prince Edward Island. Outbreaks occurred again in 1985 and resulted in moderate or severe foliage discoloration on Cape Breton Island, Nova Scotia, in parts of Kings, Albert, and Westmorland counties in New Brunswick, and on a few trees at Iona, Queens County, Prince Edward Island.

In 1986, the outbreak persisted in Inverness and Victoria counties on Cape Breton Island, Nova Scotia where the leaf browning was less severe than in 1985 but covered a larger area. In New Brunswick, only trace or light skeletonizing of white birch occurred in parts of Kings, St. John, and Sunbury counties. No foliage discoloration was observed in Prince Edward Island.

ON LARCH

Larch Casebearer, *Coleophora laricella* (Hbn.), is an introduced species, considered by some to be second in importance only to the larch sawfly as a foliage feeder on larch. The insect is usually present, but widespread, persistent outbreaks have not occurred in recent years. Populations are regulated by natural control factors including the introduced parasites *Chrysocharis laricinellae* (Ratz.) and *Agathis pumila* (Ratz.), and by certain weather conditions. In the past, populations were high in 1943, 1952, and 1959. In 1984, needle discoloration was light or moderate at locations scattered throughout mainland Nova Scotia and in Inverness County on Cape Breton Island, with populations low in New Brunswick and Prince Edward Island. Widespread defoliation occurred over much of Nova Scotia in 1985 which was especially extensive and severe in the western half of the Province.

In 1986, contrary to our prediction of continued widespread severe defoliation, populations of the larch casebearer were much reduced. Moderate and severe defoliation occurred only on individual or small groups of trees, at some locations in Digby and Yarmouth counties, moderate or light in Inverness County, light in Shelburne and Queens counties and trace in Colchester and Halifax counties. Defoliation in New Brunswick and Prince Edward Island did not exceed light anywhere in those provinces.

Fall sampling indicates that larch casebearer will not cause serious defoliation in the Region in 1987.

ON POPLAR

Poplar Serpentine Leafminer, *Phyllocnistis populiella* Cham., an insect found throughout Canada, mostly on trembling aspen, has a habit of wandering inside the leaf, taking sharp turns then doubling back, hence its name. Affected leaves take on a silverish-grey hue and when populations are high the affected stand has a silvery appearance. The insect has been common in northern New Brunswick for a number of years.

In 1986, populations remained high in the northern part of the Province and were also present at many locations in the south. Leaf mining in New Brunswick at 53 locations ranged from 0 to 100% of trembling aspen leaves affected and averaged 31%. Populations were low in the rest of the Region.

DUTCH ELM DISEASE

Dutch Elm Disease, caused by the fungus *Ceratocystis ulmi* (Buism.) C. Moreau, was a major concern in all three Maritime provinces in 1986 (Fig. 7).

In New Brunswick, the disease is present wherever elm trees are found. The resurgence of infection, reported in 1984, continued. Numerous infected and dying trees, both residual old trees and young saplings, were observed throughout the Province in 1986, although the intensification on younger trees appeared somewhat reduced from levels observed in 1985. The disease was found in two new areas for the first time in 1986. The infection in eastern Northumberland County represented only a minor extension in distribution, the other find, that on Deer Island, Charlotte County, however, represents the intrusion of the disease into a hitherto unaffected area of the Province.

In Nova Scotia, the range of the known distribution of the disease was extended considerably on Cape Breton Island as the disease was found for the first time in several areas in 1986, including the first diseased elm tree identified from Victoria County. There was a minor extension in range on the mainland as the disease is spreading into the still unaffected areas of Antigonish County. The intensification of the disease, evidenced by great numbers of dead and dying elm trees, continued

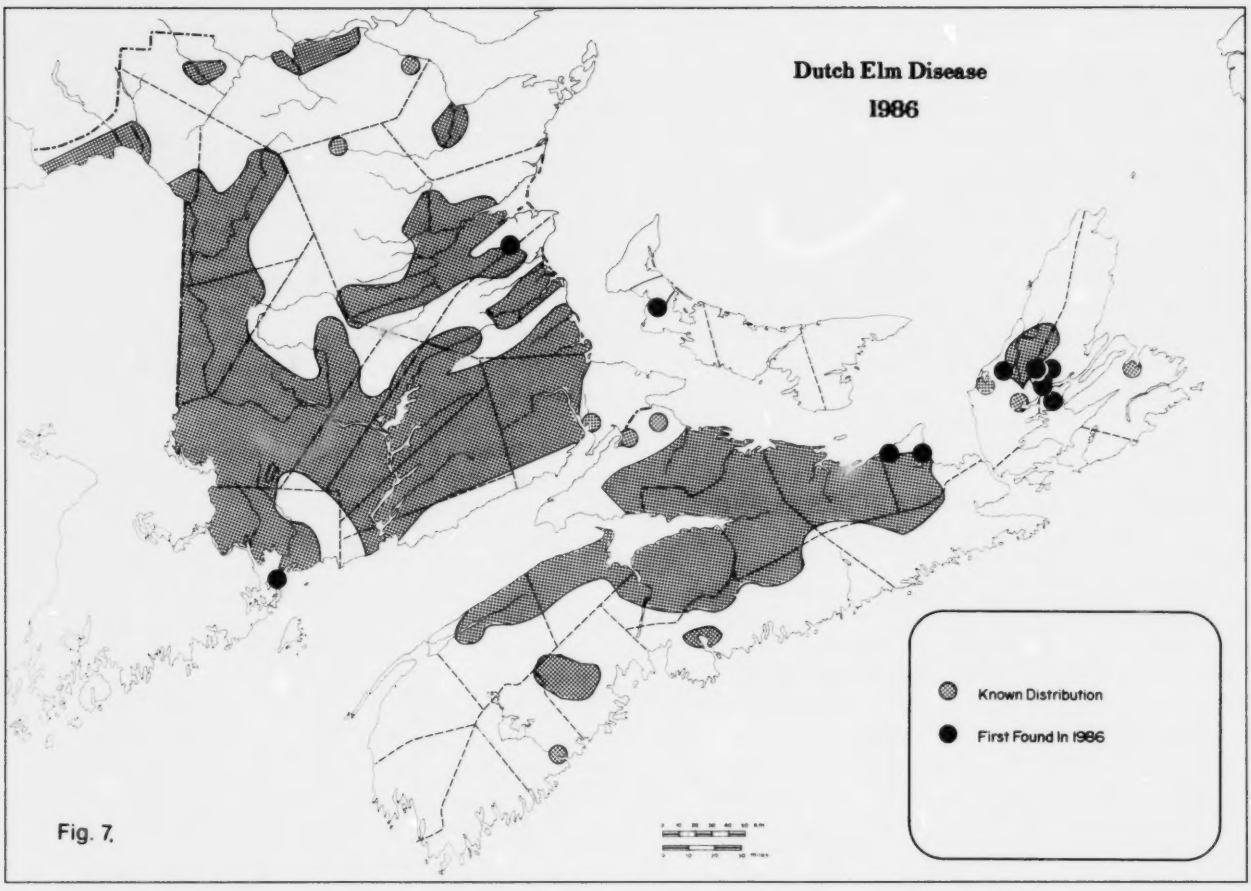


Fig. 7.

within outbreak areas where no sanitation is practiced. A multigovernmental, multiagency control program aimed at Dutch elm disease control in Nova Scotia resulted in more than 550 samples for identification by the Forest Insect and Disease Survey in 1986. Less than two-thirds of the samples received were found to have the disease.

On the permanent assessment plot near Newport, Hants County where 11% of the trees became infected between 1980 and 1982, the infection rate increased to 55% in 1983, 69% in 1984, 74% in 1985, and to 76% in 1986. The pattern agrees closely with that found in other areas of the Maritimes, although intensification here is somewhat slower, probably because some infected trees have been removed.

In Prince Edward Island, two infected trees were found in 1986 at Tyne Valley, Prince County, near the area where the disease was first discovered in 1979. The initial discovery was followed by an immediate and vigorous sanitation cut by the provincial government. No infected trees were found in 1980 and 1981, one infected tree was identified and removed in 1982, none found in 1983 and 1984, and one tree was found in 1985. There appears to be a source of infection in the general area of northcentral Prince County. Although at present the incidence of infection is low, scrupulous surveillance, increased public awareness and removal of beetle breeding material in communities where elm is of value as a shade tree are advised.

In Fredericton the progress of Dutch elm disease and the effects of the control program have been monitored since 1961 when the disease was first found in the City. The 25 trees killed by the disease in 1986 represented 0.8% of the current elm population within the Dutch Eim Disease Management Area. This loss is well in line with the reduction in the loss rate since 1980 when it peaked at 7.8% followed by 5.3% in 1981, 3.0% in 1982, 2.4% in 1983, 1.1% in 1984 and 1.2% in 1985. The 0.8% annual loss in 1986 is the lowest since 1974, the last year when the loss rate was below 1% of the current elm tree population.

Losses to date amount to 28.2% of the original urban elm stand.

No systematic survey was conducted by the Forest Insect and Disease Survey in 1986 for elm bark beetles, the carriers of Dutch elm disease, except in Fredericton, where populations of the native elm bark beetle, *Hylurgopinus rufipes* (Eichh.) remained low. One adult of the smaller European elm bark beetle, *Scolytus multistriatus* (Marsh.), was captured on a sticky monitoring trap. This insect, the more important vector in spreading Dutch elm disease in the United States and recently increasing in numbers in southern Ontario has not been a factor to date in Fredericton. One adult was captured in pheromone traps in 1982 just south of the City and in 1983 at Tay Creek, about 30 km to the north.

DETERIORATION OF WHITE BIRCH ALONG THE BAY OF FUNDY

Since 1979, early leaf browning and premature leaf drop of white birch occurred annually in southern New Brunswick and, in some years, in western Cumberland County, Nova Scotia, along the Bay of Fundy. Browning, severe every year with the exception of 1982, develops quickly and is characterized by chocolate-brown discoloration and a scorch-like appearance, which at times is restricted to leaf margins. The affected leaves curl and start dropping as early as mid-August. It was observed that leaves that develop in the latter part of the season often remain green while older leaves on the same twig turned brown. Although mainly a condition of white birch, similar symptoms were observed on other deciduous vegetation including alder, mountain ash, and mountain maple, in 1980 and 1981. The condition occurs along a coastal strip of 1 to 15 km wide and extends inland as far as 30 km, mainly along low lying areas.

In 1986, the condition was present again in essentially the same areas as in previous years, however, there was a marked reduction in the intensity of browning compared with 1985. The initial symptoms of leaf discoloration appeared later than usual in the summer and the condition was more patchy than in previous years. Foliage insects and diseases of birch were again present throughout the area, but none of these, alone or in combination, accounted for all of the discoloration. The only visible difference in conditions in 1986 was the more than the usual amount of cloud cover, consequently less sunshine. However, because the cause of the browning of white birch is unknown, this comment is offered more as an observation than an explanation. In addition to leaf browning along the Bay of Fundy Coast in New Brunswick, trace to moderate discoloration of white birch also occurred on the Nova Scotia side of the 'tip of the Fundy funnel' from Joggins to Eatonville, Cumberland County.

White birch is in very poor condition in some of the affected areas. The foliage is thin even before the early browning appears. Crown dieback, with dead twigs and branches, is evident and many trees are dead. The condition of trees has been assessed annually on a series of permanent plots established to follow the deterioration of white birch in this area (Fig. 8). The difference in the condition of trees between 1982 (when the plots were established) and 1986 indicates that there is indeed an effect of repeated early browning and premature leaf fall (Table 11) on the 11 New Brunswick plots. The cause of foliage discoloration and deterioration of white birch remains unknown. Several organisms are associated with this condition but none of them, alone or in combination, satisfactorily explains the situation.

Table 11. Change in tree condition of white birch along the Bay of Fundy in New Brunswick on 11 permanent plots between 1982 and 1986

	Trees in class, %	
Tree condition class	1982	1986
No dieback	92.9	14.5
Twig dieback only	1.5	47.3
Twig and branch dieback	4.7	31.3
Tree mortality	0.9	6.9

Each plot consists of 50 tagged trees.

The Leaf Spot Fungus, *Septoria betulina,* Pass. has been consistently present each year on the affected trees and in 1982, when the condition was least severe, accounted for much of the leaf browning. This fungus is known to have caused severe browning elsewhere in the past but not on such a large scale and not for such an extended period of time. Its association with the condition is an inescapable fact. However, where the fungus is present on white birch in other parts of the Maritimes, the symptom expression is different from that found along the Bay of Fundy. Further, *S. betulina* does not account for the leaf browning observed on other vegetation. In 1986, Septoria leaf spot was again present but was not as common as in recent years and was found associated with severe leaf browning only at Dark Harbour, Grand Manan Island, Charlotte County, Lepreau Falls, Tynemouth Creek and Martin Head, St. John County and at 45 Mile Road in Fundy National Park, Albert County.

In other areas of the Region, Septoria leaf spot and associated browning occurred on Cape Breton Island, Nova Scotia on the French, North, and MacKenzie Mountains in the Cape Breton Highlands National Park, in areas of Inverness County, on the mainland in southeastern Halifax County and to a much lesser extent in pockets elsewhere. Browning was variable, affected mostly the

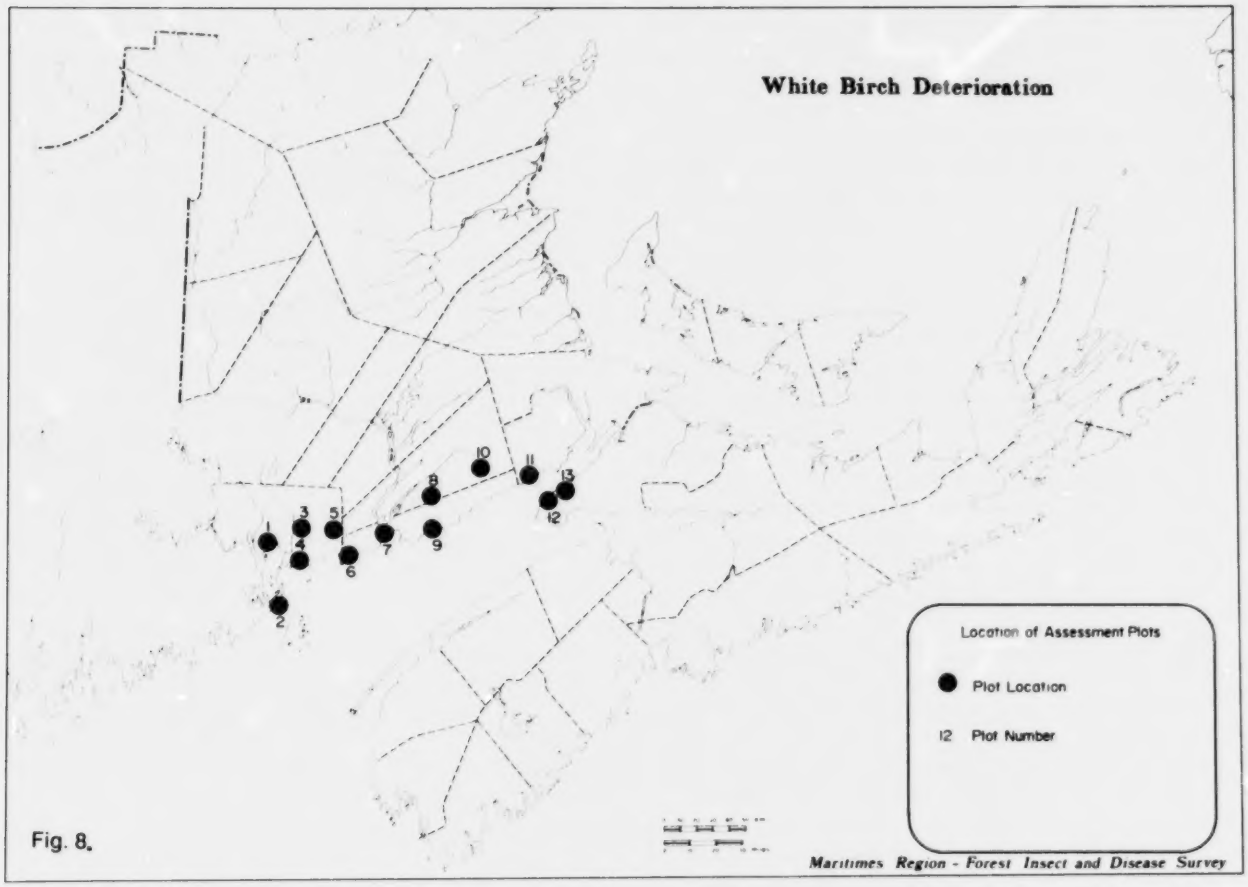

White Birch Deterioration
Location of Assessment Plots
Plot Location
12 Plot Number
Maritimes Region - Forest Insect and Disease Survey

Fig. 8.

younger trees, and was confined mostly to the lower parts of the trees. In Prince Edward Island, light browning occurred on a few young white birch trees at two locations in Kings and Queens counties and in New Brunswick, in addition to areas already mentioned, in Kings, Sunbury, York and Victoria counties.

To elucidate some of the possible factors that may be causing this condition, a multidisciplinary research effort was launched in 1986. Included are studies on the acidity of fog, nutrient availability of soils, the effect of acidity differences on the behavior of *Septoria betulina*, the monitoring of ozone levels, the acidity of rain and fog, and the continued monitoring of tree conditions and forest pest populations. A series of 24 additional plots were established at 6 locations, 3 of which are coastal and 3 are inland, away from the affected area- to increase the data base and to allow manipulation of conditions on some of them.

CONDITION OF SUGAR MAPLE IN NEW BRUNSWICK

Much has been said and written in recent years about the sugar maple decline affecting vast areas of eastern North America, especially Quebec and its effects on the maple syrup industry and other forestry-related activities. For example, an aerial survey in southeastern Quebec in 1985, involving some 2.5 million hectares of forest area, of which over 530 000 ha was of maple forest type, showed that about "40% of the maple stand area fell into dieback classes above 10%. Stem mortality was also recorded in 61% of the maple stands affected by dieback." In southern Ontario, a survey of 34 sugar maple stands in 1984 found 22.7% of the trees exhibiting some level of dieback, with 6% of the total in the severe category (FIDS National Report, 1985).

Even more has been said and written about the possible causes of the deteriorating condition of sugar maple. Opinions on the cause vary greatly, from weather patterns,

through mineral deficiencies or changes in soils, forest pest conditions, air pollution, ozone damage, and forest management practices to acid rain.

Regardless of the cause, those problems exist and concern has been expressed over the extension of decline and the status of sugar maple in the Maritimes. Early in 1986, a committee composed of the Canadian Forestry Service, the Extension Service of the New Brunswick Department of Natural Resources and Energy, and the New Brunswick Department of Municipal Affairs and Environment was established. A program was initiated to determine the status of sugar maple in New Brunswick with special emphasis on commercial operations. Following a mail survey, involving questionnaires to about 300 producers, the Forest Insect and Disease Survey conducted an assessment in the stands owned by the 42 respondents and in a few additional natural, unmanaged maple stands, as a first step preceeding more detailed surveys.

In each of the 48 stands examined, 50 maple trees were classified according to the following variables: species, diameter at breast height (dbh), tree class, dieback class, the presence or absence of sugar maple borer, and the number and condition of tap holes. A severity index was calculated for each stand by multiplying the number of trees in a given class with the assigned factor and adding these for the stand (Severity index = $[\ \Sigma$(Class factor) (No. of trees in class)$]$). Thus, a stand with 50 healthy trees has a severity index of 50, and a higher severity index indicates a stand in progressively worse condition.

The standard hardwood dieback classification used and the arbitrarily assigned "severity factor" were as follows:

Dieback class	Severity Factor
Healthy	1
Healthy but stressed	1.5
Twig dieback only	2
Branch dieback 1-25%	3
Branch dieback 26-50%	4
Branch dieback 5l %	5
'Barely alive', adventitious branches only	6
Dead - recent - no foliage green cambium at bh	7
Dead - twigs still present	8

Detailed results will be presented elsewhere, some of the information is summarized here.

Of 2400 trees assessed, 2073 were sugar maple and 327 red maple. Figure 9 shows the distribution and severity index for the stands surveyed. (The index was appropriately adjusted for sugar maple when red maple was also present in the stand.) The healthiest stands were found in northwestern New Brunswick, the poor stands were distributed throughout. Although less than one-quarter (22.5%) of the sugar maple trees in the Province were classified as healthy in terms of dieback, another 71.4% of the trees had less than 25% crown dieback (Table 12). Most trees in the 1-25% dieback category had only one or two branches affected, often associated with sugar maple borer or other disorders, and were at the "better end" of this category. Only 6.1% of the sugar maple trees were in poor condition, with more than 25% of their crown affected. In comparison, the condition of red maple was worse than that of sugar maple.

In spite of this preliminary survey overemphasizing branch dieback due partly to the wide range of the 1-25% dieback class, maple trees appear to be in generally good condition in most parts of the Province. The initial indication from a second, more detailed, phase of this project is that less vigorous trees appear in small pockets, especially west of Fredericton. No explanation is yet offered for this, however forest tent caterpillar must have had some impact on tree condition in the areas affected by the recent outbreak.

Table 12. The condition of maple in sugar-bush areas of New Brunswick in 1986

	Trees in various classes %	
Tree condition classes	Sugar maple	Red maple
Healthy	22.5	14.1
Twig dieback only	31.5	29.0
Branch dieback 1-25%	39.9	41.3
26-50%	4.4	10.7
51%	1.2	4.0
dying	0.2	0.3
Dead	0.3	0.6

Based on a survey of 48 stands, 50 trees each.
Sugar maple trees: 2073, red maple trees: 327.

MITES

Mites, as the name implies, are minute organisms, hardly visible to the naked eye. They cause damage by puncturing the surface of needles or young succulent shoots with their mouth parts and sucking out the sap. Affected foliage appears mottled or, when populations are high, reddish discoloration results. Seriously affected needles will fall prematurely. Some species of mites also produce a webbing which collects dust and debris giving affected trees a dirty, unhealthy appearance. High mite populations are often associated with dry, hot weather.

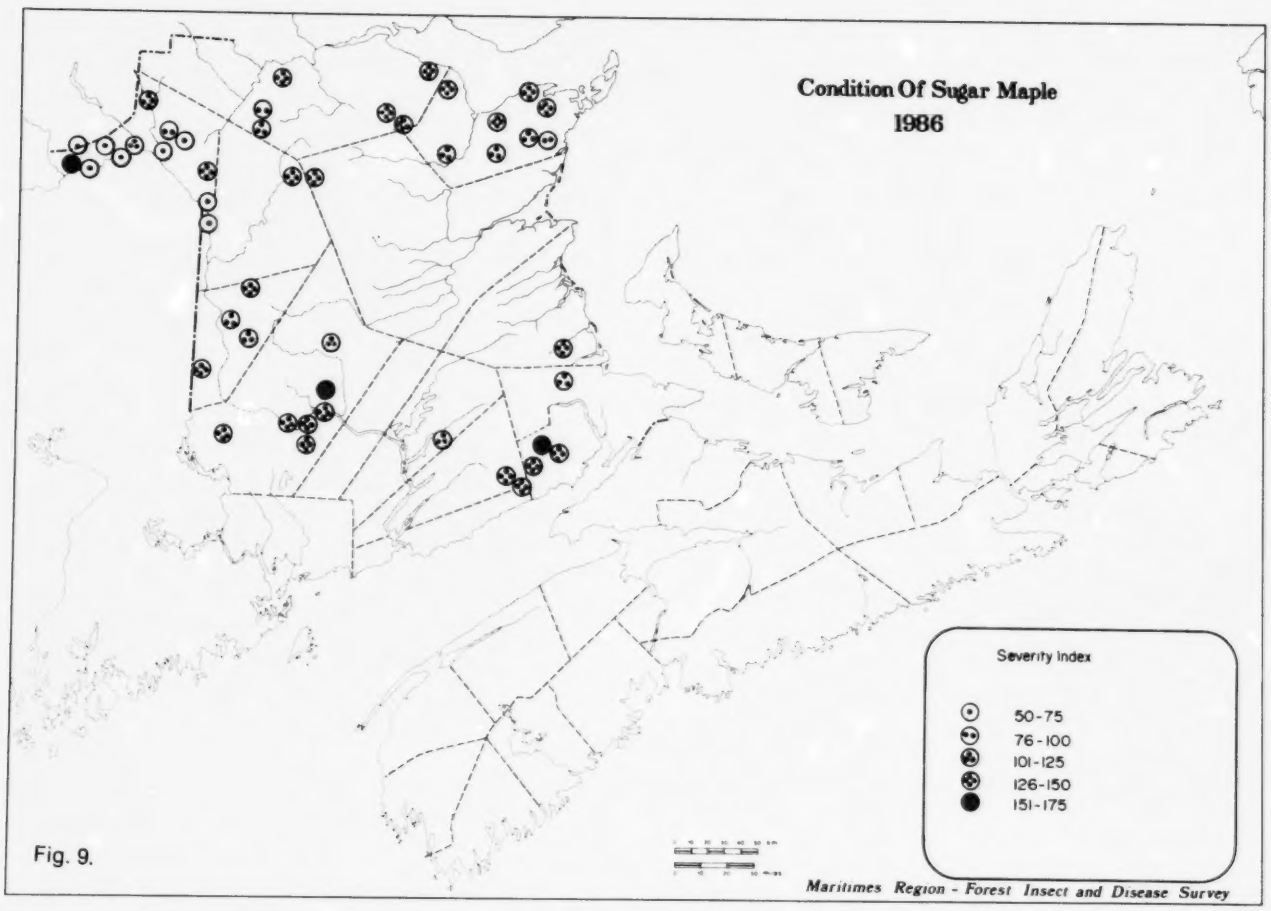


Fig. 9.

Spider mites, mainly the **spruce spider mite,** *Oligonychus ununguis* (Jacobi), on spruce and on pine, and a species of *Eurytetranychus* on spruce reached epidemic proportions in 1982 in both plantations and natural forests in southern and central New Brunswick. Although populations have declined since then, mite infested coniferous areas were observed in both New Brunswick and Nova Scotia each year since then.

In 1986, spider mites again caused various levels of discoloration in a few areas of New Brunswick and Nova Scotia occurring mainly on ornamental conifers.

A spider mite on larch, *Oligonychus laricis* Reeves, caused discoloration, ranging from trace to moderate, in a plantation of grafted stock at the Acadia Forest Experiment Station, Sunbury County, New Brunswick. This is the first record of this mite in the Maritimes Region.

Mites on pine, *Oligonychus milleri* (McGregor), and to a much lesser degree *Setoptus jonesi* (Keifer), became a major concern in 1985 as a result of various degrees of discoloration observed in numerous jack pine plantations, especially in the southern half of New Brunswick. Many of the trees were off-color, the discoloration ranging from bronze to red. The condition varied from only 4% trace discoloration to 100% severe reddening, but on average 31.5% of the shoots sustained heavy feeding, 10.8% moderate, 13.2% light, 14.7% trace feeding, and 29.8% were healthy.

In 1986, a regional survey for spider mites in red and jack pine plantations found that while *O. milleri* was the most frequently encountered species, a large group of other mites is also associated with these trees. The effect of most of these on the trees is uncertain. Foliage discoloration associated with mites was widespread, but did not exceed light, in New Brunswick. In Nova Scotia, severe and moderate discoloration occurred in patches, ranging in size from one to several hectares on the Trafalgar burn area of Pictou and Guysborough counties, with discoloration of lesser intensity at many places elsewhere in the Province. In Prince Edward Island, spider mites were found at nine of ten plantations examined but

discoloration was negligible. The only exception occurred in a 2-3 ha jack pine plantation at North Enmore, Prince County, where discoloration occurred in 1985, and was re-examined in 1986. Spider mite populations were still present although at levels lower than in 1985. Trees in the areas with severe discoloration last year either died or had some level of top mortality. Trees in the area of lesser damage last year showed a marked improvement in color from 1985, no top mortality occurred and none of these trees died.

Studies were initiated in 1986 to determine certain aspects of the life cycle in order to establish timing for control, and to devise a sampling technique to assess mite populations reliably in the field.

WHITEMARKED TUSSOCK MOTH

Whitemarked Tussock Moth, *Orgyia leucostigma* (J.E. Smith), is a defoliator of considerable ecomonic importance. Larvae feed on a variety of coniferous and deciduous hosts. Outbreaks of this insect are usually short but severe, followed by several years of very low populations.

The last outbreak of whitemarked tussock moth in the Maritimes was in the early 1970s and collapsed by 1979, mainly due to a nuclear polyhedrosis virus. Populations were low until 1984 when the first signs of a new build-up were observed. By 1985, the insect, although still at generally low populations, was common in most of mainland Nova Scotia and in southern New Brunswick. A further increase was predicted for 1986.

In 1986, whitemarked tussock moth was present in many areas in the Region (Fig. 10) but caused noticeable defoliation only in eastern mainland Nova Scotia. Defoliation at various levels of intensity was somewhat patchy depending on forest cover type, and affected white birch, red maple, apple, larch, and balsam fir. The most serious defoliation was in the Ogden-Roman Valley-Giant Lake-Cross Roads Country Harbour-Ogden area of north-eastern Guysborough County, from Sherbrooke to

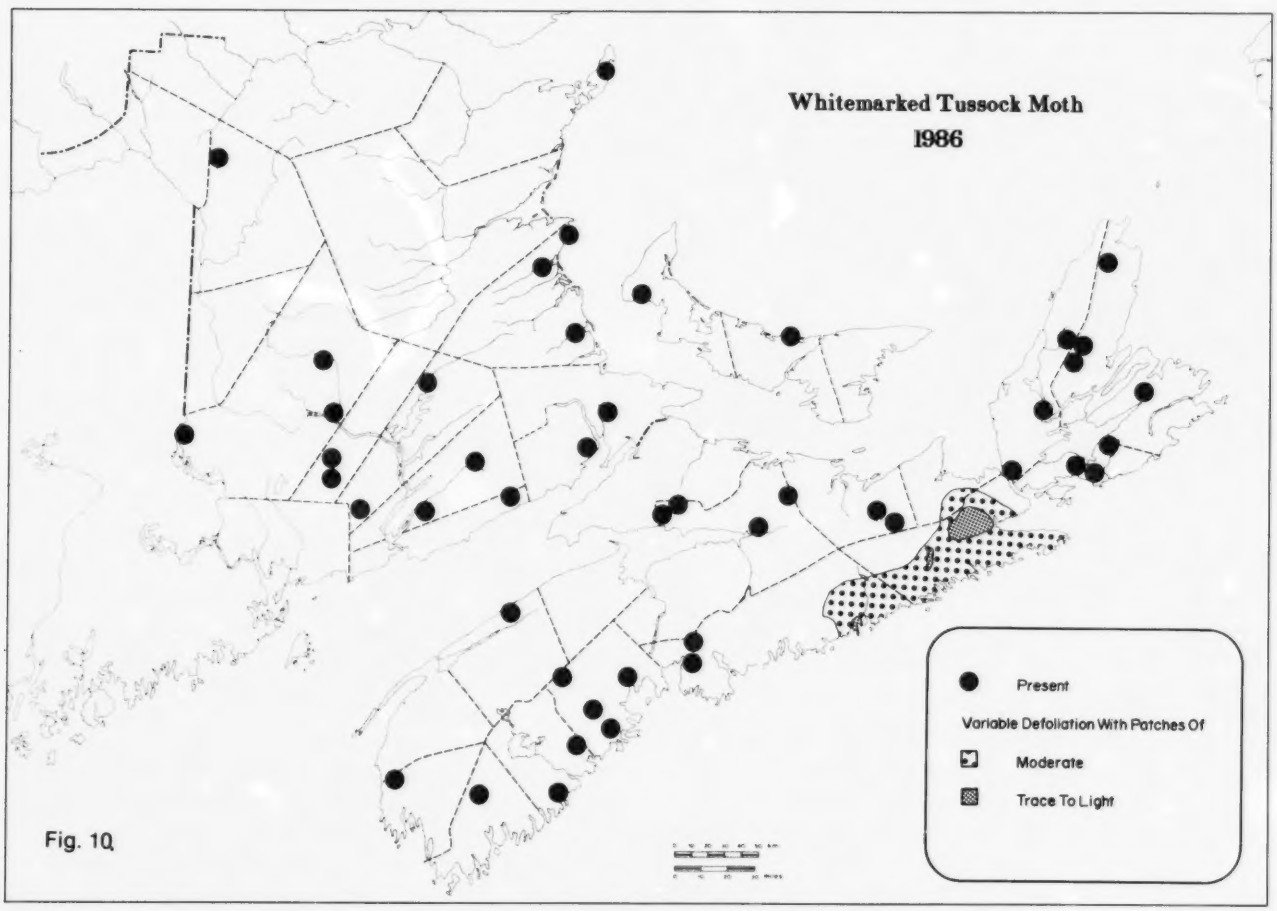


Fig. 10

Melrose in central Guysborough County, and from Spry Bay to Sheet Harbour in southeastern Halifax County. Diseased larvae were present at several locations in these two counties which may indicate a collapse of the population before it becomes a full-blown outbreak.

Egg-mass counts were generally low in Nova Scotia, however a sudden increase in light trap catches at Liverpool, Queens County (256 adults caught in 1986 compared with 77 in 1985) suggests a possible upswing in populations in 1987 in that part of the Province. Egg-mass numbers in New Brunswick indicate a further increase in 1987, while in Prince Edward Island populations are expected to remain low.

HEMLOCK LOOPER

Hemlock Looper, *Lambdina fiscellaria fiscellaria* (Gn.), contrary to its name, is mainly a defoliator of balsam fir in the Maritimes. It is capable of causing serious damage when populations are high. It feeds on needles of all age classes and is a wasteful eater. Larvae chew off but do not consume all of the needles, consequently a much greater amount of foliage is removed than necessary for their development.

In the Maritimes, populations have been generally low in the past few years. The last serious outbreak occurred in central Prince Edward Island in 1977 and 1978 when the insect killed 80% of the merchantable balsam fir and over 90% of the hemlock in the affected area.

In 1986, the hemlock looper population, reported in 1985, persisted in the area of Diligent River, Cumberland County, Nova Scotia. Many balsam fir trees are in poor condition but this is partly due to the presence of the spruce budworm. The Nova Scotia Department of Lands and Forests carried out an aerial control program with the biological insecticide *B.t.* (Dipel 132R), applied (at 30 BIU/ha), over 136 ha in this infested forest. A major moth flight was reported late in the season in the Diligent River -Fox River area of Cumberland County which suggests that the infestation may persist into 1987. Populations of the insect were low in the rest of the Province.

In Prince Edward Island, the infestation collapsed near Cross River, Kings County, where patchy, but in some places severe defoliation was reported in 1985. The insect was present in a few other areas but generally at low populations. Light defoliation occurred on a few balsam fir trees at Devon, Kings County.

In New Brunswick, hemlock looper populations remained generally low. The highest populations were observed in the Alma area of Albert County but even there no noticeable defoliation occurred.

SEED ORCHARD PESTS

The establishment of seed orchards created a new category of high value areas in the Maritimes Region. Seed orchard and seed production are as important to nursery programs as seedling production in nurseries is to plantation programs. Consequently, anything that interferes with seed orchards also affects most other phases of forestry operations aimed at future wood production. Forest pests in seed orchards, both insects and diseases, have the potential to affect seed production seriously, either directly, by destroying seed or cones, or indirectly, by affecting the condition of trees, thus interfering with their ability to produce seed. The following, which is not intended to be all inclusive, was gathered with the cooperation of R. Smith, CFS-Maritimes, and various seed orchard managers.

Insects

Spruce cone maggot *Hylemya anthracina* (Czerny) infesting 5-90% of cones on several white spruce grafts in Nova Scotia, and a pine cone beetle *(Conophthorus* sp.), in southeastern New Brunswick were the only insects found in 1986 directly affecting cones.

Insects, with effect on trees rather than directly on cones: the **eastern spruce gall adelgid** *Adelges abietis* (L.), formed 4 or 5 galls per tree on 25-30% of white spruce grafts in Nova Scotia; **aphids,** *Cinara* sp. infested 50% of the trees in an eastern white pine seed production stand in Nova Scotia, 50% of the trees in a larch stand in New Brunswick and was found on 2% of the trees in a white spruce stand in Nova Scotia; **larch shoot moth,** *Argyresthia laricella* Kft., was common on larch in New Brunswick.

Other insects found in seed orchards included the **spruce budworm** *Choristoneura fumiferana* (Clem.), **spruce bud scale** *Physokermes piceae* (Schr.), and **spruce spider mites** *Oligonychus* sp., on spruce, the **northern pitch twig moth** *Petrova albicapitana* (Busck) on pine, and the **orange larch tubemaker,** *Coleotechnites laricis* (Free.), on larch.

Diseases

Cone rust *Pucciniastrum americanum* (Farl.) Arth. was found on white spruce at very low levels in four areas in the Region. This rust, which was present at epidemic proportions in 1984, can be a destructive disease (Smith *et al.* 1986). It was the only disease directly affecting cones.

Sirococcus shoot blight *Sirococcus conigenus* (DC.) P. Cannon & Minter infected 60% of the red pine trees in a residual stand within a southern New Brunswick seed orchard. This stand was harvested in 1986 to prevent the disease from infecting seed orchard trees. **A spruce needle rust** *Chrysomyxa ledi* dBy. was present on 90% of

white spruce trees, affecting from 1 to 30% of needles, in a Nova Scotia seed orchard and in another orchard in that Province, affected 5-10% of the trees at trace level. **A needle rust on larch,** *Melampsora medusae* Thuem, infected 10% of the trees at a New Brunswick Location.

NURSERY AND GREENHOUSE PESTS

Successful seedling production is essential to avoid or at least to minimize the shortfalls in wood production predicted to occur in the future. Seedling production is as important to plantation programs as seed production is to nurseries. Pests affecting nursery production increase the cost of meeting the objectives of forestry.

Some of the conditions encountered in 1986 in nurseries and greenhouses are mentioned because of their importance and to demonstrate that no facet of forestry is without problems. The year was a very "light" one for major problems. This could be a reflection on the performance of nursery managers to prevent problems from developing, or on their ability to deal with these as they occur. The following, which is not intended to be all inclusive, was gathered with the cooperation of R.D. Hallett and T.W. Burns, (CFS-Maritimes).

Insects

Spider mites *Oligonychus* sp. was found on Norway spruce in a nursery in Nova Scotia. This appears to be a recurring problem at this location, although spider mite numbers were low in 1986. **Owlet moth** *(Noctuidae)* larvae were found on less than 1% of 3 million black spruce paper pot stock in a New Brunswick nursery.

Diseases

Sirococcus shoot blight *Sirococcus conigenus* (DC.) P. Cannon and Minter affected less than 2% of a 1.5 million black spruce crop in a Nova Scotia nursery, and was found on 3% of jack pine container stock in another nursery in the Province. The **gray mold** *(Botrytis* sp.) affected 3.4% of white spruce container stock at a Nova Scotia nursery.

Abiotic factors

Abiotic factors damaging seedlings included: fertilizer burn, nutrient deficiencies, water quality, winter injury, handling problems during transport and poor root development.

CHRISTMAS TREE PESTS

Among the many pests of balsam fir Christmas trees, the spruce budworm is by far the most significant in most areas of the Maritimes. Some of the others, usually only of localized importance, are mentioned elsewhere in this report. The balsam gall midge and the balsam twig aphid are discussed here because of their widespread occurrence and because of their effect on the quality and, consequently, on the value of Christmas trees. They are discussed not strictly from the point of Christmas tree production, but because their presence in natural stands has a spill-over effect, the statements are relevant. Another insect, the whitemarked tussock moth, is discussed elsewhere (page 30) but because of its effect on the quality of Christmas trees in some areas a mention of it is made here.

Balsam Gall Midge, *Paradiplosis tumifex*, Gagne, was again low throughout the Region in 1986. In New Brunswick, populations were low at scattered locations and the insect caused problems only on one Christmas tree plantation at Gagetown, Queens County where infestation was severe. The level of infestation by the balsam gall midge was determined at 1021 locations during the spruce budworm L2 sampling conducted by the New Brunswick Department of Natural Resources and Energy. Of these, 910 locations were negative (89%); at 106 locations 1-10% of the needles were affected (10%); at 4 locations the infestation was in the 11-20% range and only at one location was the infestation in the above 20% category. Although the above represents samples from larger trees used to determine spruce budworm populations, the figures are comparable to our results obtained from Christmas tree plantations and are a good indication of the distribution of balsam gall midge populations in the Province in 1986. In Nova Scotia, the highest level of infestation, at 16% of the needles affected, occurred west of Neils Harbour, Victoria County. Populations were low elsewhere in the Province. In Prince Edward Island, balsam gall midge affected needles were found only at two of the 22 locations sampled during spruce budworm L2 surveys but infestations were at less than 20% at both Selkirk (11-20%) and Primrose (1-10%) in Kings County. At seven randomly selected areas of the Province less than 2% of the needles were affected on only 10% of the trees.

Balsam Twig Aphid, *Mindarus abietinus* Koch, was common throughout the Region but, with a few exceptions little shoot damage occurred in 1986. In New Brunswick, an average of 7% of the shoots was affected at the 50 locations assessed during our surveys. The insect was recorded as "present" at 203 (20%) of the 1021 locations assessed by the New Brunswick Department of Natural Resources and Energy during the spruce budworm L2

surveys. Similar to the situation in 1985, affected trees were most common in the northeastern part of the Province where 33% of the samples were positive. In Nova Scotia, the highest level of infestation was found in two silviculturally thinned areas on the Cape Breton Highlands, with 35 and 36% of the shoots affected. In Prince Edward Island, the insect was found only at three of the 22 locations assessed during spruce budworm L2 surveys and occurred at Selkirk and Primrose, Kings County and near West Point, Prince County. At six other randomly selected areas the level of shoot damage was 5-10% on about 10% of the trees.

Yellow Witches' Broom of Balsam Fir, *Melampsorella caryophyllacearum* Schroet., a rust fungus, which needs chickweed as an alternate host to complete its life cycle, is often found in the natural forest but until recently, has not been a serious problem in Christmas tree plantations in the Maritimes. Serious damage occurred in a few plantations, especially in areas where chickweed ground cover was heavy and affected the quality of Christmas trees. In 1986, the disease was detected at various locations in New Brunswick and Nova Scotia but the production of new brooms appeared to be much reduced from 1985. An average of 12% of the trees bore brooms in four areas assessed in Kings and Queens counties, Prince Edward Island but only single brooms were found on the affected trees.

SPECIAL SURVEYS

ACID RAIN NATIONAL EARLY WARNING SYSTEM

Acid rain has been a global concern for the past few years and the effects of impurities in the air, on lakes, buildings, and the forest are becoming more apparent in many parts of the world.

Acid rain means more than just rain with lower than normal pH. falling from clouds that come from elsewhere. It includes any form of acid, both wet and dry, precipitation, and air pollutants of different kinds from both near and far. These, alone or in combination, directly or indirectly affect the health of Canada's forests, by interfering with their normal development, the production of wood, or with their role in providing a healthy environment.

Concern about the future of the Canadian forests has intensified as a result of the alarming tree mortality observed in other parts of the world. The Acid Rain National Early Warning System (ARNEWS) came into being in the early part of 1984, when the Canadian Forestry Service established a national program to detect, clearly and accurately, early signs of acid rain damage to Canada's forests before damage becomes obvious.

The objectives of the program are:

1. To detect the possible damage to forest trees and soils caused by acid rain or to identify the damages sustained by Canadian forests (trees and soils) which are not attributable to natural causes or management practices;

2. Long-term monitoring of vegetation and soils to detect future changes attributable to acid deposition and other air pollutants in representative forest ecosystems.

   The Forest Insect and Disease Survey was charged with the responsibility for (1) plot establishment, (2) above-ground parameter monitoring and sampling, (3) providing assistance in obtaining foliage and soil samples for chemical analysis.

   Permanent plots are to be maintained in all Regions of Canada to monitor:

a. the condition and changes in the condition of the forest stand,

b. the presence and fluctuation of biotic and abiotic factors that affect the condition of the forest (insects, diseases, stand changes, temperature, etc.),

c. the changes and symptoms that indicate factors not attributable to the above that could conceivably be early signs of acid rain damage, and

d. the effect of acid rain on the condition of the various economically important tree species.

The rationale behind the above is that without close monitoring of all of the factors mentioned, the expected, initially subtle, effects of acid rain cannot be isolated and identified.

In the Maritimes Region, 15 permanent ARNEWS plots, representing the important forest species and geographical areas were established in 1984. Two additional plots have been established in northwestern New Brunswick in 1985 at the request of and in cooperation with Fraser Inc. (Fig. 11). These will be monitored jointly with the Company in future years.

In 1986, all plots were visited monthly from June to September to determine forest insect and disease conditions, detect 'acid rain' symptoms (if any), observe seed crop and premature fall discoloration, to collect ground vegetation samples, and to sample lichens and mosses found on trees. In August, detailed assessments of all plots were carried out following the procedures developed by the Maritimes FIDS unit for the national system.

Foliage samples from conifers are now available for analysis from 8 ARNEWS plots (Nos. 201, 202, 204, 205, 206, 207, 216, 217), from hardwoods from 5 plots (Nos. 201, 202, 203, 206, 216) and soil samples from 4 plots (202, 203, 205, 207). Information from increment cores collected in 1984 has been computerized, in cooperation with the Petawawa National Forest Institute, and preliminary analysis started (10 cores per species per plot constituting at least 10% of stand).

Tree mortality on all ARNEWS plots increased to 11.4% in 1986, compared with 9.3% in 1985 and 8.3% in 1984.

In addition to the work on permanent plots, the results of observations for signs of possible acid rain damage were recorded for most of the 280 locations where detailed pest condition assessments were made. Special attention was directed to the number of years of needle retention on coniferous species. A summary of some of these observations is presented in Table 13. It is apparent that the percent of needles retained decreased with age of foliage and the rate of the decrease varied among tree species and between provinces. It is important to realize that figures represent provincial averages and, more important, that at least some of the loss is definitely attributable to feeding by defoliating insects. Similar information was

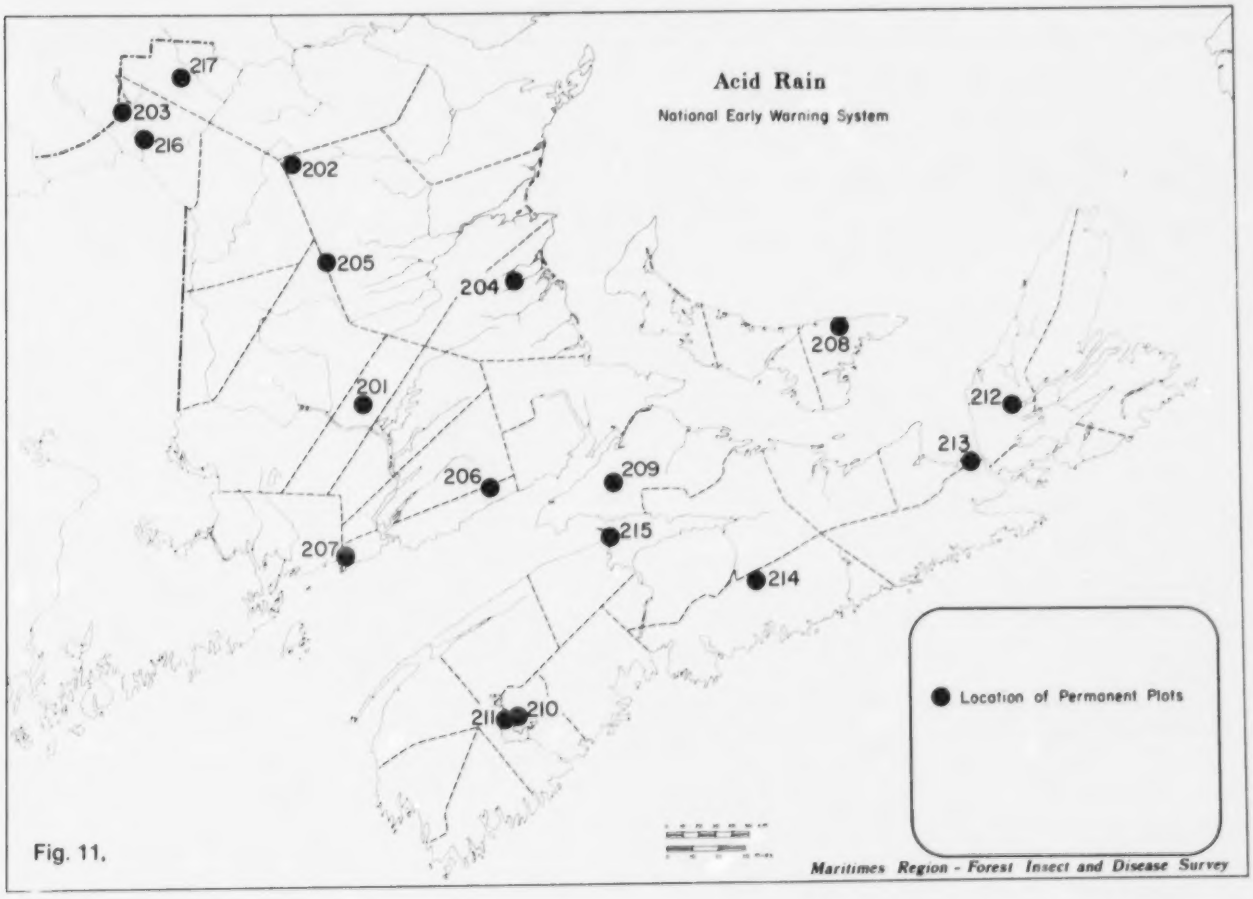


Fig. 11.

collected in 1985 in our effort to build a data base that will allow analysis of possible changes.

Forest Insect and Disease Survey personnel are always on the lookout for unusual or unexplained forest conditions, some of which are conceivably suspect for acid rain damage.

In 1985, in the course of general aerial surveillance, an unexplained deterioration of white spruce was observed in northern New Brunswick. The condition involved areas of several hundred hectares in the vicinity of Squaw Cap (elevation 483 m), Slate Mountain and Mann Mountain in Restigouche County. Mainly mature trees were affected but other age classes were also deteriorating to some extent. Upon further investigation in 1986 this condition proved to be the result of insect damage.

Also in 1985, in the southern part of New Brunswick, red spruce was found in a deteriorating condition at many locations on Deer Island, Charlotte County. Although trees in many of these areas have been defoliated by the spruce budworm in the past this does not adequately explain the condition observed. In 1986, permanent observation plots, each consisting of 50 trees, were established in Charlotte and Sunbury counties in New Brunswick and in Hants, Cumberland, and Halifax counties in Nova Scotia to follow changes in condition of trees. The summary of the tree conditions at the five plots is presented in Table 14 and constitutes only base-line information without comment.

The deterioration of white birch along the Bay of Fundy (see page 26) was first noticed in 1978. The condition has been under surveillance and has been reported annually since 1979. In 1986, research was initiated to determine if "acid rain" is a causal factor in the repeated foliage browning and early leaf fall in this area.

FOREST PEST ASSESSMENT IN PLANTATIONS

The increasing importance of planted trees in forest management resulted in the initiation of an annual plantation-assessment program in 1982. The lessons learned

Table 13. Retention of needles produced in different years by various coniferous trees in the Maritimes Region - 1986

Species	Province	No. of observations	Needles retained of the needles produced in the year indicated							
			1986	1985	1984	1983	1982	1981	1980	1979
Balsam fir	New Brunswick	73	92	77	60	41	33	28	26	14
	Nova Scotia	43	100	95	86	75	72	60	36	13
	Prince Edward Island	8	81	68	72	62	46	32	11	0
White spruce	New Brunswick	41	91	90	74	50	35	26	17	14
	Nova Scotia	25	99	97	92	80	75	55	32	10
	Prince Edward Island	18	81	78	80	69	62	24	0	0
Black spruce	New Brunswick	9	100	91	89	86	68	54	43	34
	Nova Scotia	5	100	100	98	86	58	28	10	8
	Prince Edward Island	4	100	98	95	82	80	28	1	1
Red spruce	New Brunswick	47	97	87	79	60	57	41	29	18
	Nova Scotia	24	98	92	86	78	63	50	37	20
Norway spruce	Nova Scotia	1	100	100	100	90	10	0	0	0
Spruces (combined)	New Brunswick	97	95	89	78	58	49	36	25	18
	Nova Scotia	55	98	95	90	80	67	49	32	14
	Prince Edward Island	22	84	81	83	72	65	25	0	0
Red pine	New Brunswick	1	100	100	100	100	90	0	0	0
	Nova Scotia	2	100	100	95	70	0	0	0	0
	Prince Edward Island	1	90	80	0	0	0	0	0	0
White pine	New Brunswick	8	100	89	58	0	0	0	0	0
	Nova Scotia	12	100	83	23	1	0	0	0	0
Jack pine	New Brunswick	4	99	80	42	10	0	0	0	0
	Nova Scotia	5	96	75	37	22	10	1	0	0
Scots pine	Prince Edward Island	1	100	100	100	90	0	0	0	0
Lodgepole pine	Nova Scotia	1	100	100	100	80	0	0	0	0
Pines (combined)	New Brunswick	13	100	87	56	11	7	0	0	0
	Nova Scotia	20	99	84	38	17	2	0	0	0
	Prince Edward Island	2	95	90	50	45	0	0	0	0
Hemlock	New Brunswick	2	100	100	90	5	5	0	0	0
	Nova Scotia	1	100	80	40	10	0	0	0	0
Douglas fir	Prince Edward Island	1	90	90	90	80	2	0	0	0

Table 14. Condition of red spruce at five permanent plots in the Maritimes in 1986

Tree condition class	Trees in various condition classes, %				
	New Brunswick		Nova Scotia		
	Charlotte Co.	Sunbury Co.	Hants Co.	Cumberland Co.	Halifax Co.
1 Healthy, no defoliation	4	0	14	0	100
2 Healthy, only current defoliation	38	0	0	0	0
3 More than current but less than 25% total defoliation	50	64	46	12	0
4 Total defoliation 26-50% no bare top	6	28	36	74	0
5 Total defoliation 26-50% with bare top	2	8	4	14	0

from agriculture and from experience with large-scale forest plantings suggest that tracts of even-aged, single species forests will bring with them special pest problems. Previously insignificant pests may take on new importance and many of the well-known pests may change their habits in the new environment. Among these are the spruce bud moth, Sirococcus shoot blight, Armillaria root rot, needle rust on jack pine, mites and seedling debarking weevil, which are described in some detail in other chapters of this report. As our knowledge of pest outbreaks in plantations increases, our methods of establishing and tending them must incorporate ways to offset the effects of such pests, if we wish to avoid or minimize losses.

Our plantation surveys attempt to determine the status of all significant insects and diseases. The plan was to assess at least one host species each year in selected plantations throughout the Maritimes to obtain a general picture of pest problems. This was to indicate the need for detailed surveys of plantations in specific areas in cooperation with clients. Although plantation selection is random, new plantations were initially avoided to eliminate problems associated with site selection and establishment techniques.

Other work priorities resulted in the cancellation of specific regional surveys since 1984 although numerous observations were made in plantations. The results of these have been reported as appropriate.

The realization of the importance of forest pests to the future wood supply in New Brunswick resulted in the first large-scale joint plantation survey between the provincial Department of Natural Resources and Energy and the Forest Insect and Disease Survey of the Canadian Forestry Service-Maritimes in 1985, to assess the general state of health of plantations and of silviculturally treated (thinned) areas. There were large-scale joint surveys conducted in the past. However, all previous surveys were pest specific in response to crisis situations, such as the Scleroderris survey in 1979, in the wake of the discovery of the European race of that disease in the Province. The survey in 1985 was conducted as a pilot project in anticipation of regular, continuing surveys in future years.

In 1986, the Department of Natural Resources and Energy and the Forest Insect and Disease Survey were joined by two of New Brunswick's larger forest companies, J.D. Irving Ltd., and Fraser Inc., in carrying out extensive pest assessment surveys in plantations. The ensure uniformity and standardization, both field and classroom instruction courses were conducted in advance of the actual field work.

There were 140 plantations assessed by the three organizations. The Department of Natural Resources and Energy also assessed 14 thinned areas. Fifty-nine percent of the areas selected were visited twice. Observations were made on the type and the level of forest pest disturbances or damage. Field assessments were carried out by staff of the three organizations. Identification of samples and data analysis were done by the Forest Insect and Disease Survey. Table 15 summarizes the number of plantations assessed, by species, by the cooperating agencies and Figure 12 shows the distribution of the assessed areas.

There were 245 assessments made in the 141 plantations and 14 silviculturally treated areas. A total of 12 250 trees was examined in the course of the survey.

The results of the surveys will be presented elsewhere, a brief summary is offered here:

1. The most remarkable - and comforting - observation drawn from the results is that, in spite of a long list of organisms encountered, plantations of both spruce

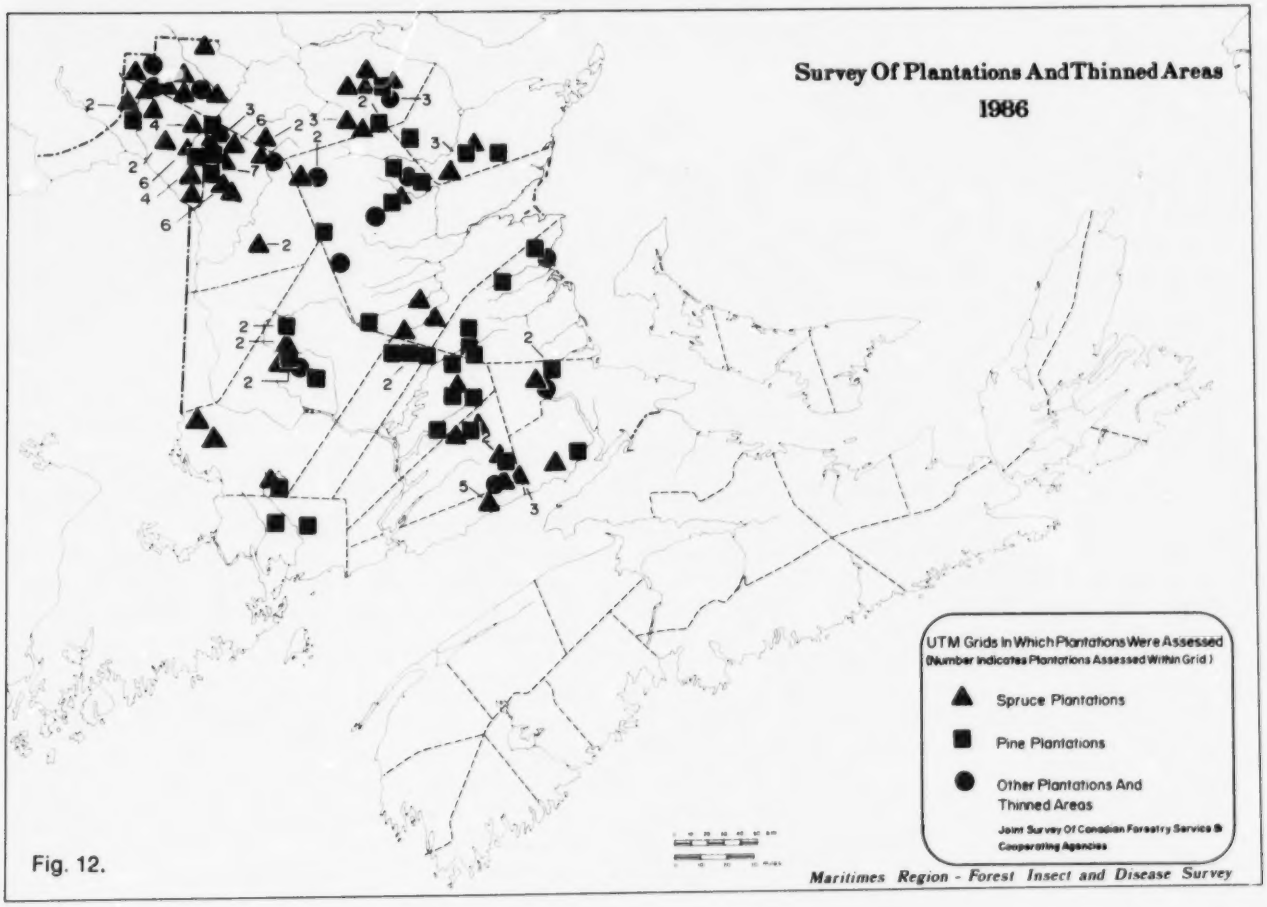

Survey Of Plantations And Thinned Areas
1986
UTM Grids In Which Plantations Were Assessed
(Number Indicates Plantations Assessed Within Grid)
Spruce Plantations
Pine Plantations
Other Plantations And Thinned Areas
Joint Survey Of Canadian Forestry Service & Cooperating Agencies
Maritimes Region - Forest Insect and Disease Survey

Fig. 12.

and jack pine were found to be generally in very good condition in New Brunswick in 1986. An average of over 92% of both spruce and pine trees were classified as healthy.

2. Only 1.1% of the pine and 2.4% of the spruce trees were dead and tree mortality ranged from 0.3% of pine in DNRE Region 1 to 3.4% of spruce in DNRE Region 5. At least some of the tree mortality is caused by Armillaria root rot.

3. Current defoliation was extremely variable among regions and ranged from 73% on spruce in DNRE Region 5 to only 8% on pine in DNRE Region 1. The level of defoliation was mostly trace, and moderate or severe defoliation was observed on less than 1% of the trees assessed in the Province.

4. Needle diseases, mostly needle rusts, were common, but, with the exception of DNRE Region 3, only occasionally reached light intensity. In DNRE Region 3, the jack pine needle rust was still at the highest levels in the Province, but was much reduced from those in previous years. This disease is discussed in more detail on page 15.

5. Buds were found healthy on 98% of the pine and 87% of spruce trees with little variation in this condition throughout the Province.

6. Leaders were healthy on 90 and 79% of pine and spruce, respectively, and less than 2% were dead on either species.

7. Multiple leaders were reported on 9.2% of pine and 16.5% of spruce trees in the Province. However, regional variation,3 to 18% on pine and 2 to 23% on spruce, was so great, that it is questionable whether these figures are true or represent observer bias; their validity is suspect.

Table 15. Summary of plantation assessment by tree species and organization conducting field work - 1986

DNRE Region	Species	Total plantations assessed	Organization		
			DNRE	Irving	Fraser
1	Black spruce	10	7	1	2
	White spruce	2	2		
	Spruce	3	3		
	Jack pine	9	9		
	Pine	1	1		
	Total for region	25	22	1	2
2	Black spruce	4	4		
	White spruce	1	1		
	Jack pine	6	6		
	Total for region	11	11	-	-
3	Black spruce	10	9	1	
	White spruce	4	3	1	
	Norway spruce	1		1	
	Spruce	2	1	1	
	Jack pine	16	13	3	
	Total for region	33	26	7	-
4	Black spruce	6	6		
	White spruce	1	1		
	Jack pine	7	7		
	Total for region	14	14	-	-
5	Black spruce	29	4	21	4
	White spruce	18	3	15	
	Norway spruce	2		2	
	Spruce	2		2	
	Jack pine	4		3	1
	Red pine	1		1	
	Larch	2			2
	Total for region	58	7	44	7
	Total for N. B.	141	80	52	9

8. Branch, stem, and root damage was reported for both pine and spruce but the level of damage was generally low. The exception was jack pine in DNRE Region 3 where 13% of the branches were damaged, probably by a combination of globose gall rust and the northern pitch twig moth.

The 14 thinned areas assessed included 12 stands of various combinations of fir and spruce, one stand of jack pine and one hardwood stand where yellow birch was the dominant species. All stands were in good condition with 70-100% of the trees considered healthy with the exception of one fir-spruce stand in DNRE Region 5 where 66% of the trees were classified as damaged.

CYCLICAL REVIEWS FOR SPECIFIC PESTS

Many pests, although omnipresent in the forest, are not reported annually because (1) there is little fluctuation in their distribution or in the damage they cause, (2) they normally cause so little damage that regular surveys cannot be justified, or (3) they are present in such small numbers that they are easily overlooked during routine assessment surveys. However, these organisms are a part of the pest component in the forest and, although separately each may cause little damage, their combined effects can weaken the trees, reduce growth, or expose them to other problems. Forestry practices are changing and some organisms, until now obscure and unimportant in their natural habitat, are changing in importance and the damage caused by them is becoming significant.

Several of these 'other' insects and diseases are reviewed most years, often in connection with surveys involving a specific host species. The number depends on other activities, which determine the time available, and the time required for specific surveys. The results provide an assessment of the current status of the organism and a benchmark to which past and future assessments are compared.

Since 1982 when we first started reporting the results of cyclical reviews the status of the following forest pests has been determined: larch shoot moth and spruce gall midge in 1982; balsam shootboring sawfly, eastern dwarf mistletoe, northern pitch twig moth and larch needle casts in 1983, the latter in response to concerns over the discovery of a newly introduced species to Canada; bronze birch borer and birch ambrosia beetle, in connection with the deterioration of white birch along the Bay of Fundy in 1984.

In 1986, other priorities did not allow for special assessments of this type but we plan to continue with cyclical reviews in the future, especially when supporting evidence is required to explain certain forest conditions.

PINEWOOD NEMATODE

The Pinewood Nematode, *Bursaphelenchus xylophilus* (Steiner and Buhrer) Nickle has gained worldwide attention in recent years, mostly because of its implications to international trade of forestry products. (Reported as *B. lignicolus* in our 1985 report).

Nematodes are a class of "elongated, cylindrical worms, parasitic in animals or plants or free-living in soil or water" (Webster's Seventh New Collegiate Dictionary, 1970). The pinewood nematode was first identified in North America in the late 1970s and was believed to have been imported from Japan where it has been reported to have killed trees for at least 30 years. Since then it has been reported to be widely distributed in the United States and in 1982, was reported in southern Manitoba. In 1985, the nematode was found in Ontario.

The pinewood nematode is a plant-parasitic species that kills trees by rapidly multiplying in the water conducting elements after having been introduced into the trees by some wood-boring insect, such as sawyer beetles or bark beetles. The exact vector is not known but cerambycids are suspected. The affected tree, with its water supply cut off, wilts and dies within a short time. The fact that many species of nematodes may be present in trees, most not pathogenic, and that the identification of these microscopic organisms is extremely difficult has resulted in considerable confusion as to the cause of tree mortality in some areas and as to the actual distribution of the pinewood nematode itself.

In the Maritimes, the pinewood nematode (referred to earlier as the Japanese wood nematode) has been a special concern of the Forest Insect and Disease Survey since 1980. Through general observations, forest condition assessment surveys, plantation surveys, pest extension activities, provincial cooperative surveys and special surveys, staff have been on the lookout for symptomatic suspect trees. In the five years from 1980 to 1984, 15 such trees were located. These included red pine, Scots pine, white spruce and balsam fir. Nematodes were extracted from some of these and submitted for expert identification. Reports indicated that none of the samples submitted were of the pinewood nematode. In 1984 suspect nematodes were extracted from two samples (one a balsam fir, one a white spruce). One sample contained two species of nematodes, a bacterial feeder and a mycophagous species (fungus eater). The nematode from the other sample was identified as 'definitely not pinewood nematode'. Also in 1984, several bark beetles from stressed balsam fir were tested as possible vectors for the pinewood nematode- with negative results.

In the fall of 1985 and the summer of 1986 a special survey was conducted as part of a national effort to establish the presence and distribution of the pinewood nematode in Canada. Recently dead, old dead, and a few living trees were sampled and from a number of locations, insects considered possible vectors for the nematode were also analyzed. In total, samples were obtained from 185 locations, 119 in New Brunswick, 55 in Nova Scotia, and 11 in Prince Edward Island. The distribution of sampling areas and results are shown in Figure 13. The various host-samples are shown in Table 16.

Although the objective was to obtain a good species mix in sampling, balsam fir received special attention, especially in the early part of the survey, because of the

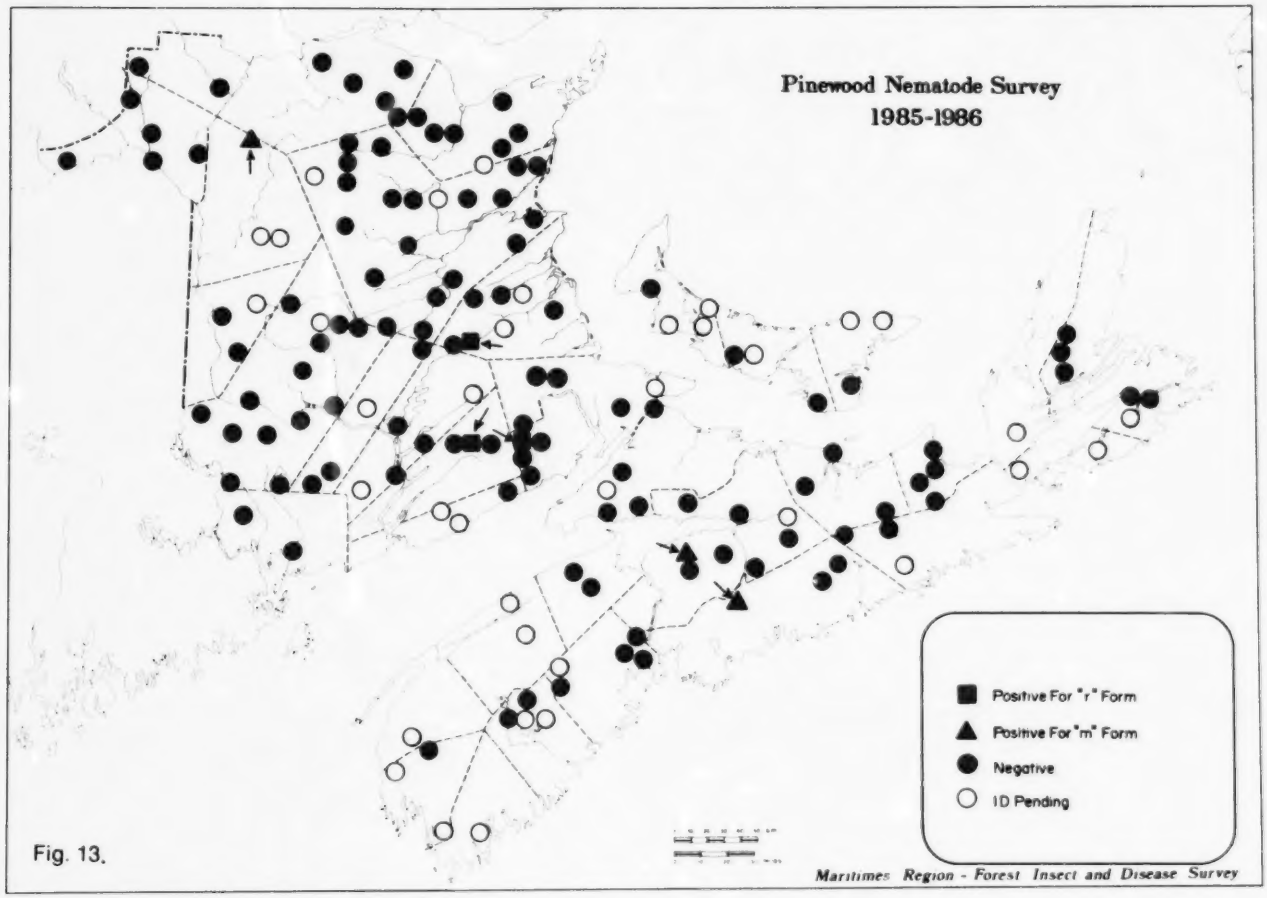


Fig. 13.

Table 16. Summary of pinewood nematode surveys in the Maritimes Region in 1985 - 1986

	Maritimes Region	New Brunswick	Nova Scotia	Prince Edward Island
No. of locations sampled	185	119	55	11
Tree species		Number of samples		
Balsam fir	157	87	58	12
Jack pine	40	40	-	-
Red pine	13	6	6	1
Scots pine	18	12	5	1
White pine (eastern)	41	18	19	4
Black spruce	49	17	29	3
Red spruce	16	8	8	-
White spruce	22	13	6	3
Total no. of trees sampled	356	201	131	24
Insects sampled				
Sawyer beetle (*Monochamus* sp.)	15	14	1	-
Seedling debarking weevil(*Hylobius* sp.)	23	7	16	-
Total no. of insects sampled	38	21	17	-
Total no. of samples (trees and insects)	394	222	148	24

similarity in symptom expression between Stillwell's Syndrome (see page 8) and the supposedly sudden wilting of conifers when killed by the pinewood nematode. No pinewood nematode has been identified from any of the balsam fir trees that succumbed to the Stillwell's Syndrome.

Pinewood nematode, the so-called "r" form of *B. xylophilus*, has been identified at three locations in New Brunswick. In each case only one tree at the site was positive and none of the trees was considered to contain high enough populations of pinewood nematode to have been the direct cause of tree death. Pinewood nematode was found in a recently dead jack pine tree at Nevers Brook, Kent County, in a windthrown, recently dead jack pine tree in the Hebron Mountain area, Kings County and in a recently dead white pine tree at Pleasant Mountain, Albert County.

Another *Bursaphelenchus*, the so-called "m" form, which is an affiliate of uncertain connection and is said to be non-pathogenic, has been identified at three other locations, one in New Brunswick and two in Nova Scotia. Again, in each case only one tree at the site was positive and the nematode was present in very low numbers, not high enough to have killed the trees. The "m" form was found in a recently dead balsam fir at Sisson Branch, Victoria County, New Brunswick in a recently dead balsam fir at Devon, Halifax County, Nova Scotia and in a recently dead black spruce on the Stanley Management Unit, Hants County, Nova Scotia.

There is, to date, no evidence to justify the pinewood nematode in the Maritimes as an organism of biological importance (i.e., a tree killer) but the consequences of its presence may be economically significant, if it affects our ability to export some forest products, such as wood chips, because of plant quarantine regulations in other countries.

PHEROMONE SURVEYS

Organizations, involved in the detection or monitoring of insect population fluctuations, to predict infestations or to organize control measures, strive for more reliable, economical, and effective operational tools. Chemical communication is important in the behavior of insects. They are attracted to various stimulants and this behavioral characteristic is utilized in several ways.

Females send a chemical message by releasing a pheromone that stimulates the male to search for the female for the purpose of mating. In other cases, the insect, male or female, may be attracted to odors given off by a tree signalling a suitable condition for the insect, to attack the tree, usually in connection with propagation.

Attractants can be used to lure insects to traps where they are caught, roughly in proportion to the adult population present in the immediate area. These catches, when correlated to other life stages or more importantly to the defoliation or damage caused by the insect the following year, then become predictive tools that can replace or complement other survey methods. Pheromones can also be used for control either by causing mating disruption or by capturing significant numbers of the insect.

In the Maritimes, the Forest Insect and Disease Survey, often in cooperation with other organizations, has been in the "pheromone business" since 1971, when traps were first used in detection surveys for the gypsy moth, 10 years before the first egg mass was found. Since then, our efforts have gradually increased, first with opportunities to cooperate in testing various compounds for researchers, then by including testing in our program to develop pheromones as survey tools. Depending on the level of available precision, pheromones are used for:

1. detection surveys to establish the presence of an insect;

2. monitoring surveys to indicate a threshold of concern for the initiation of further action, such as more precise surveys or issuing an early warning of an impending population build-up;

3. monitoring surveys to predict the level of injury, such as defoliation, and subsequent damage, such as growth loss.

Currently most pheromones used in the Maritimes are still in the developmental stage and are used either as detection or threshold monitoring tools. However, work towards damage prediction capabilities is in progress.

In 1986, pheromones or attractants were used for a number of insects and comments on these follow.

Spruce budworm - As part of an interregional and international testing program to determine the reliability of traps and pheromones in monitoring annual changes in populations of the spruce budworm, the system was tested at 41 locations in the Maritimes in 1986. Cooperating in the program were the New Brunswick Department of Natural Resources and Energy (10 locations), the Nova Scotia Department of Lands and Forests (5 locations), J.D. Irving Ltd., (5 locations), E.G. Kettela of CFS-Maritimes (10 locations), and the regional Forest Insect and Disease Survey (10 locations).

Multipher traps baited with PVC pellets were used in a cluster of three traps deployed at each location (Figure 14). Trees at each location were sampled in the early

summer to determine spruce budworm larval populations at the L3-L4 stage, adult males captured by the traps were counted at the end of the flight period, defoliation levels on the sample trees were determined at L2 counts, an indicator for next year's expected population levels, were obtained. The results of the various counts are summarized in Table 17. Where available, the L2 counts from 1985 are included for comparison.

No detailed analysis is yet available but correlations appear to be much better than obtained in 1985, when the results were, for the most part, useless because of start-up problems with the killing agent-lure combination.

Forest tent caterpillar - Trap catches have corresponded well to the areas of defoliation observed and, more importantly, with the results of late fall egg-mass surveys during the last three years. Also, pheromone trapping of adult males appears to be more sensitive than the traditional egg-mass surveys. The technique should enable us to detect earlier, and predict more accurately, future population fluctuations. This system will eliminate the traditional, expensive, and time consuming fall surveys. In 1986, only nine of the 78 areas sampled were positive and catches even at those were very low (Fig. 15). The 11% positive catch obtained in 1986 compares with 40% in 1985 and 60% in 1984. These figures accurately reflect the decline of the most recent outbreak (page 20).

Jack pine budworm - Initial work on this pheromone coincided with a small and short-lived population rise in central New Brunswick in 1983, allowing for a determination of a gradient in catch numbers correlated to population differences in various areas. Results of three years' trapping indicate that we now have a technique similar to that used for the forest tent caterpillar, which can be used to monitor fluctuations, at least at low levels, of jack pine budworm populations without having to resort to time honored, traditional, expensive surveys. Not having had the opportunity to test the system at higher population levels, more work will need to be done when that situation occurs. However, the trap system will help determine when populations start to rise again. In 1986, trap catches were lower than in 1985 and even at locations with the highest number of males caught (Fig. 16) there was no evidence of defoliation. The overall population was also lower in 1986 as the number of positive traps was reduced to 60% from the 84% in 1985 in New Brunswick.

European pine shoot moth - Traps in young red pine stands indicate a population somewhat higher in 1986 than was recorded in 1985, when most traps were negative. However, the numbers of moths caught this year were still lower than in 1984. Because the population has been generally very low during the past few years the testing of these traps will have to wait. In 1986, all 9 traps were negative in New Brunswick, 71% of the 24 traps were negative in Nova Scotia and 28% of 7 traps negative in Prince Edward Island (Fig. 17).

Spruce bud moth - Pheromones developed by other agencies and used in 1985 in the northwestern New Brunswick outbreak area were tested as a survey tool in the Maritimes in 1986. No analysis of the results is yet available.

Gypsy moth - The pheromone trapping detection survey has been used in the Maritimes since 1971. The program is a multiagency effort and is discussed in detail elsewhere in the report.

THE LIGHT TRAP MONITORING SYSTEM

Taking advantage of the fact that many insects are attracted to light the Forest Insect and Disease Survey has been monitoring insect populations since shortly after the Second World War. The trap, with a built-in light source, captures and kills the insects which are later identified and counted. The information is used several ways, such as in designing other types of surveys, predicting population buildups and in scientific research.

The 16 light traps in the Maritimes Region, listed below and shown on Fig. 18, are maintained by provincial government cooperators, National Parks personnel, industrial concerns, or private individuals on behalf of the Forest Insect and Disease Survey and operate from mid-April until the late fall. Catches are collected daily and the material is submitted for identification on a weekly basis. All traps and light sources have been standardized since 1976 and trap locations remained the same except in a few emergency situations.

Light trap locations in the Maritimes Region are as follows:

NEW BRUNSWICK

Ashton Hill, Northumberland County
Balmoral, Restigouche County
Canterbury, York County
Fredericton, York County
Fundy National Park, Albert County
Mayfield, Charlotte County
Plaster Rock, Victoria County

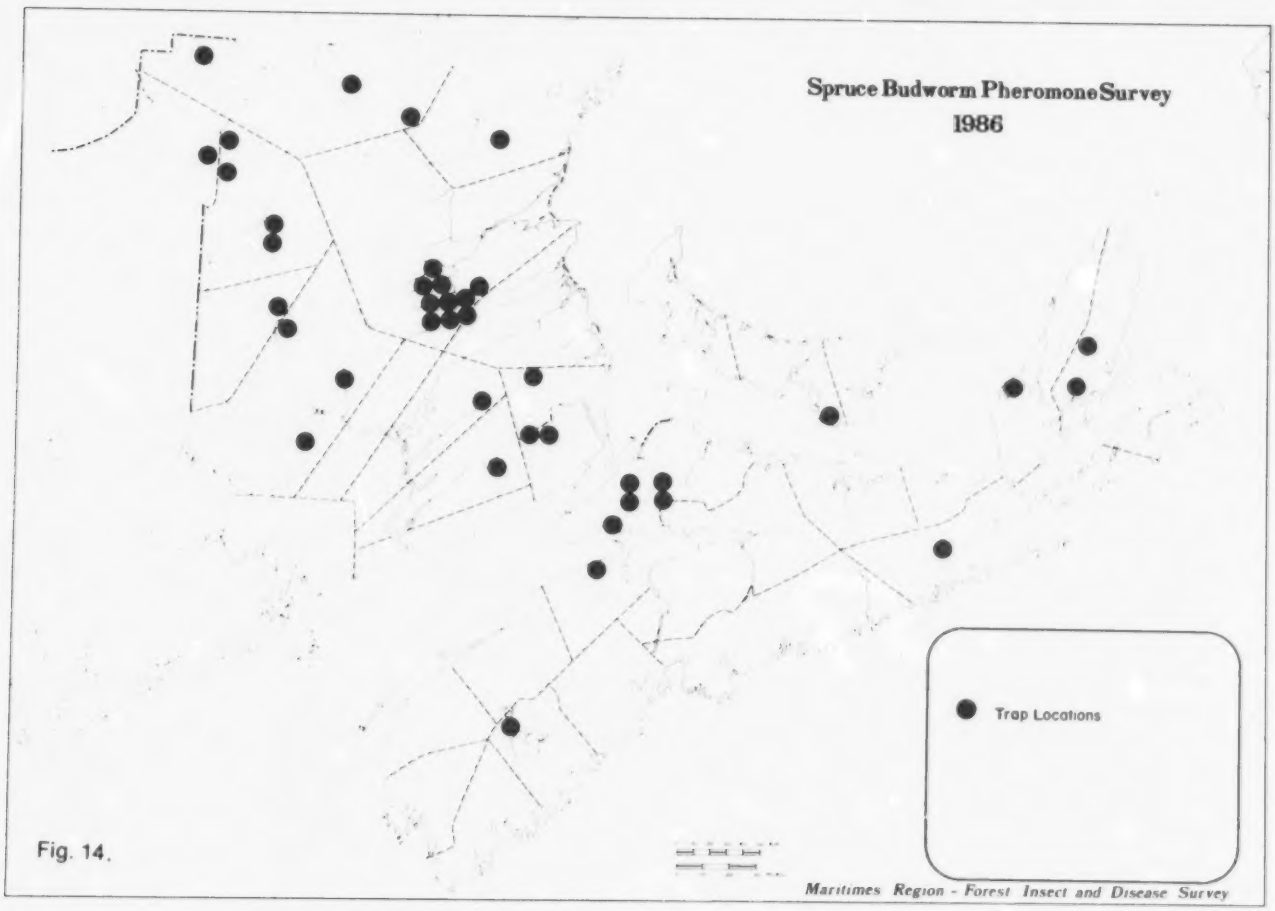

Spruce Budworm Pheromone Survey
1986
Trap Locations
Maritimes Region - Forest Insect and Disease Survey

Fig. 14.

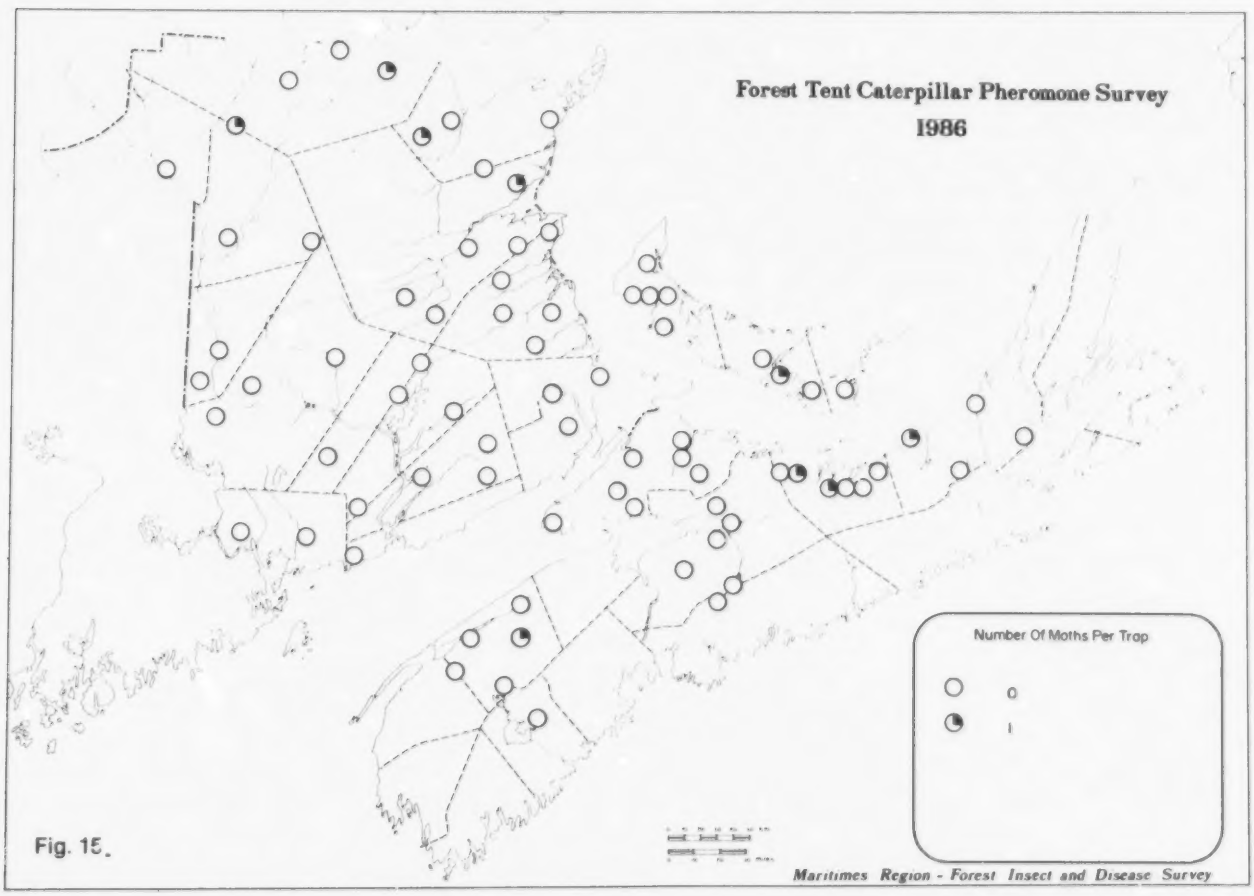

Forest Tent Caterpillar Pheromone Survey
1986
Number Of Moths Per Trap
0
1
Maritimes Region - Forest Insect and Disease Survey

Fig. 15.

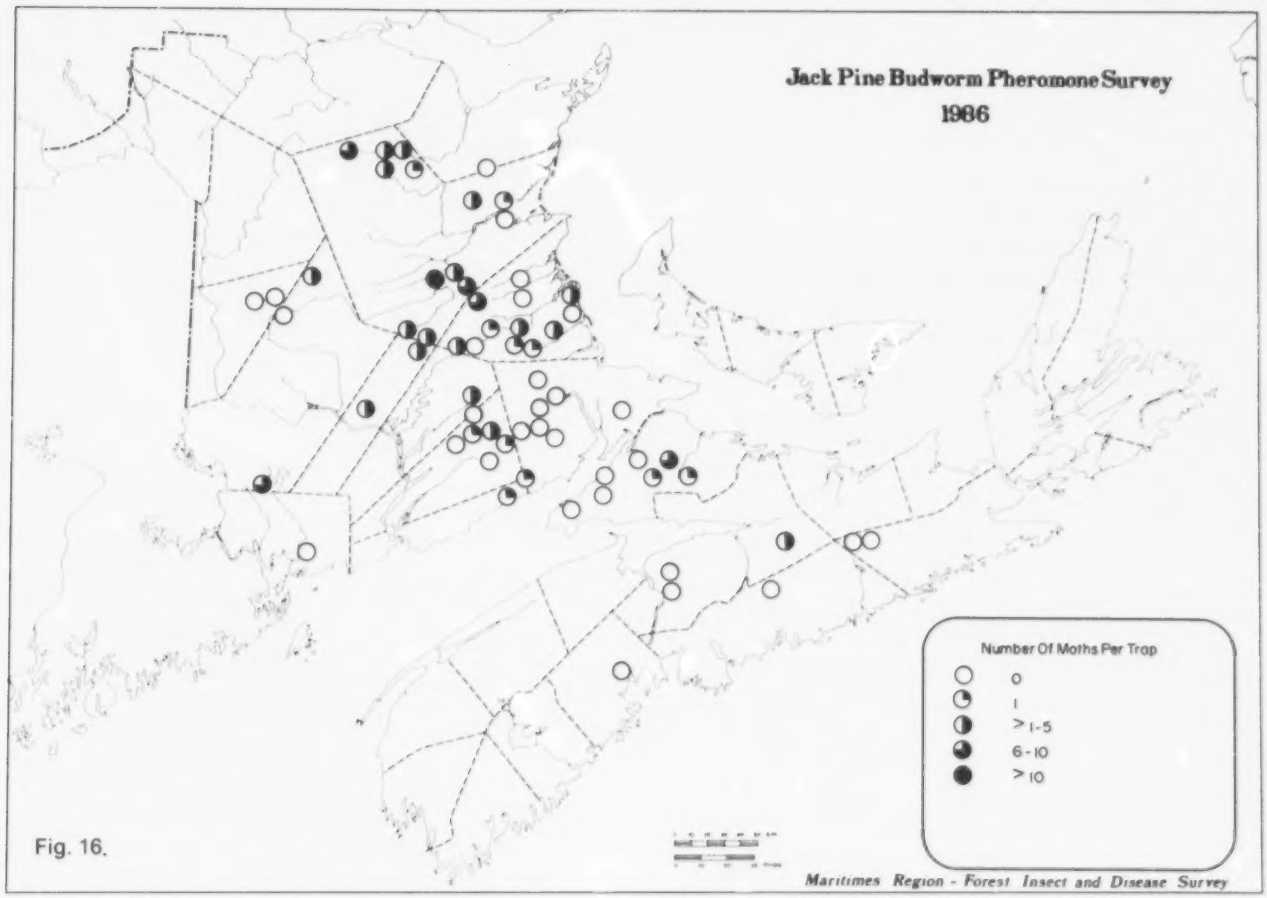

Jack Pine Budworm Pheromone Survey
1986
Number Of Moths Per Trap
0
1
>1-5
6-10
>10
Maritimes Region - Forest Insect and Disease Survey

Fig. 16.

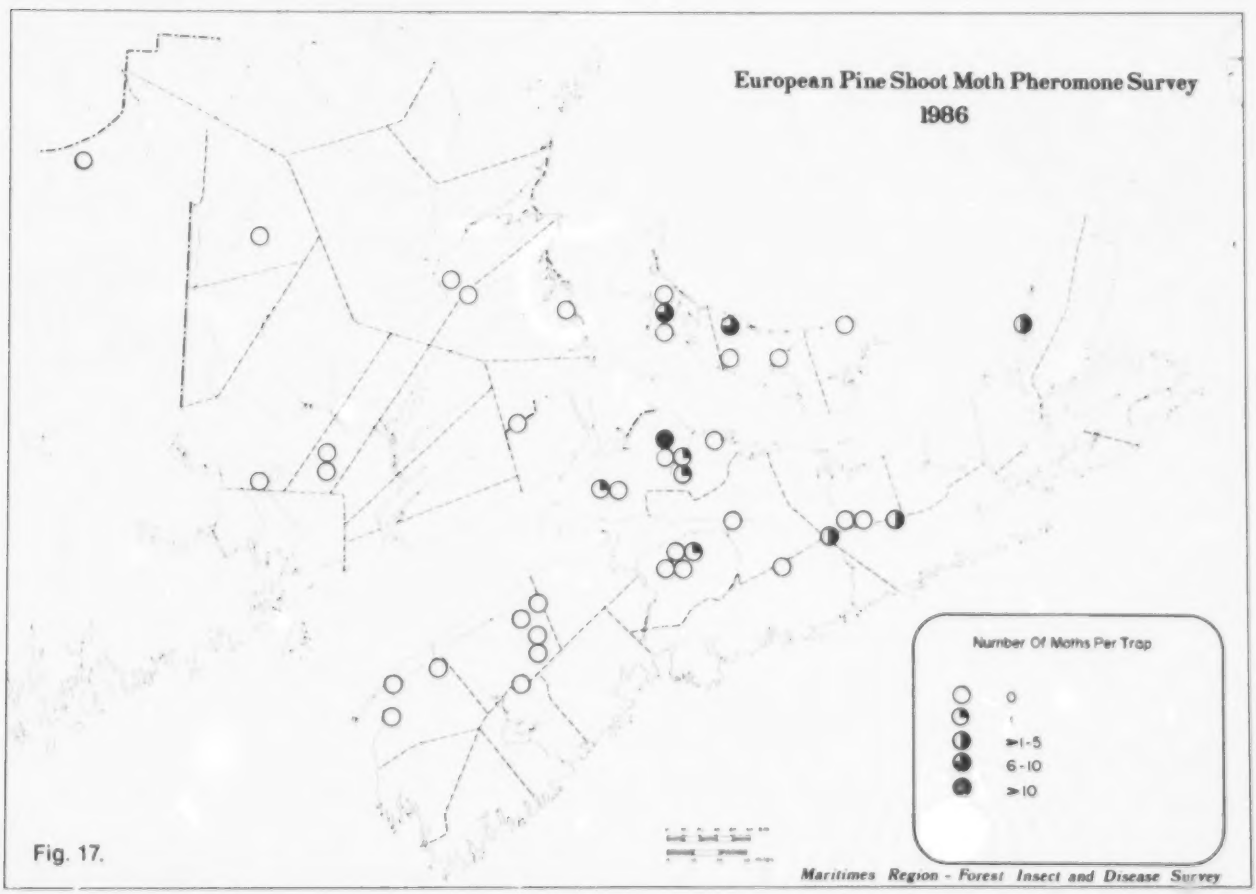

European Pine Shoot Moth Pheromone Survey
1986
Number Of Moths Per Trap
0
1
>1-5
6-10
>10
Maritimes Region - Forest Insect and Disease Survey

Fig. 17.

NOVA SCOTIA

Big Intervale, Victoria County
Georgeville, Antigonish County
Kejimkujik National Park, Annapolis County
Lawrencetown, Annapolis County
Liverpool, Queens County
Londonderry, Colchester County

PRINCE EDWARD ISLAND

Breadalbane, Queens County
Howlan, Prince County
Kilmuir, Kings County

For an illustration of how light trap catches reflect the fluctuation or the build-up, then collapse of populations, the reader is referred to the figures presented for the lesser maple spanworm on page 23.

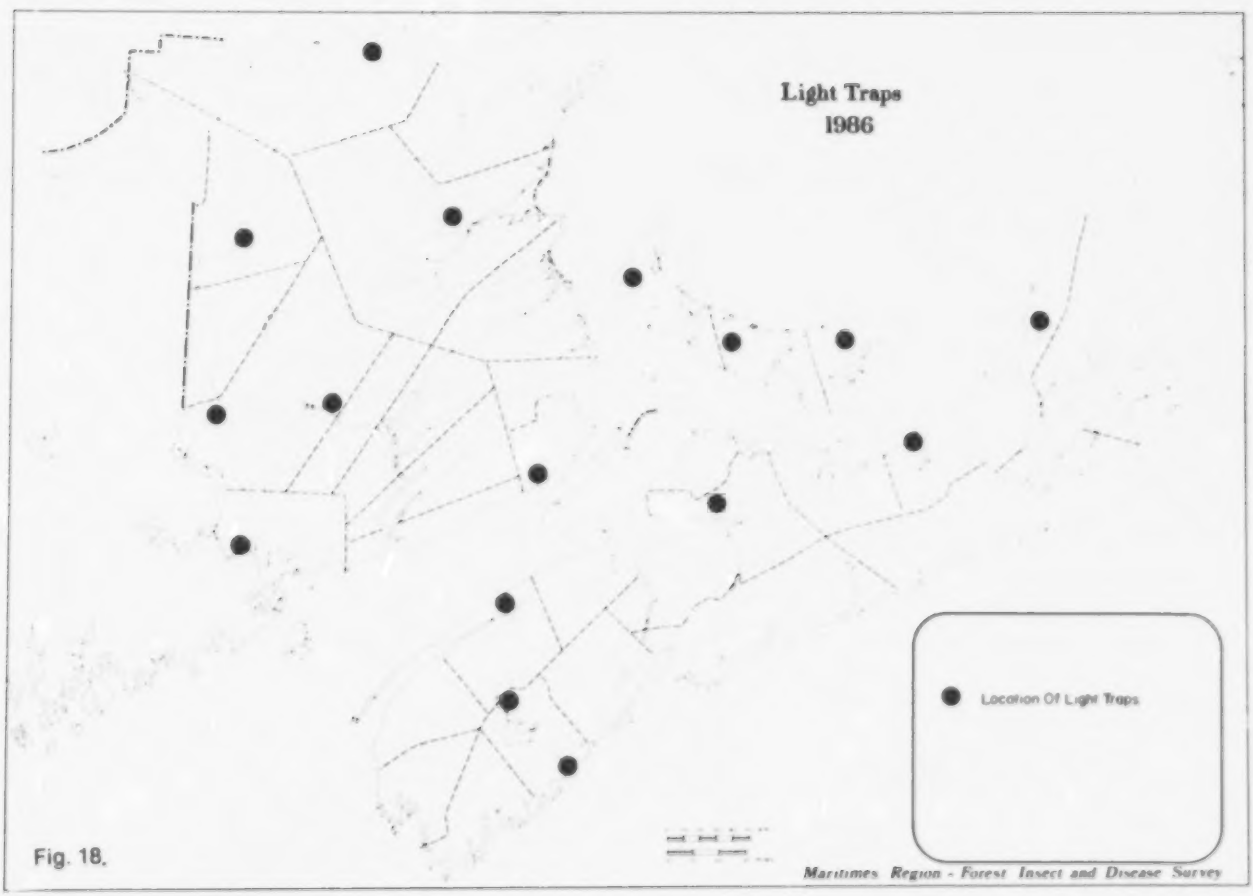


Fig. 18.

TABLE 17. Spruce budworm pheromone trapping - Maritimes - 1986

Location	UTM Grid	Host	1985 L2	L3-L4 larvae per m	Pheromone trap catch 1	2	3	Ave	Defoliation Visual % Ave	Fettes % Ave	1986[1] L2	CoOp Agency
New Brunswick												
Parkindale Seed Orchard Station No. 2, Albert Co.	20-34(1)-508(2)	bF	-	0.1	4	0	3	2	11	4	0.2	JDI
East Branch Canaan River Westmorland Co DNRE No. 10	20-33(5)-512(0)	S b/r	-	40	176	129	288	198	35	16	15.3	DNRE
Parkindale Seed Orchard Station No. 1, Albert Co.	20-33(9)-508(2)	bF	-	0	12	8	5	8	11	11	0.0	JDI
Allardville East Gloucester Co. DNRE No. 4	20-31(4)-526(2)	bF	-	121	167	191	150	169	9	16	0.3	DNRE
Sussex Tree Nursery, Kings Co.	20-31(8)-506(8)	wS	-	0.1	58	20	54	44	12	3	0.0	JDI
W of Despres Lake Northumberland Co.	20-30(1)-516(9)	F S	-	140.5	178	281	569	343	33	31	3.3 11.7	CFS
Forks Stream Queens Co. DNRE No. 9	20-30(2)-510(8)	S b/r	-	102	352	203	245	267	35	13	5.3	DNRE
SE of South Lake Northumberland Co.	20-29(9)-516(9)	F S	-	82.1	306	163	318	262	25	20	5.3 0.3	CFS
S of East Branch Sabbies River, Northumberland Co.	20-29(2)-515(8)	F S	-	35.7	420	229	174	298	27	23	6.0 1.0	CFS
Shinnickburn Rd SE of Upper Blackville Bridge, Northumberland Co. DNRE No. 5	20-28(1)-516(5)	S b/r	-	20	182	143	216	180	7	10	4.3	DNRE
West Branch Sabbies River, Northumberland Co.	20-28(9)-515(5)	F S	-	42.3	238	102	202	181	26	23	2.0 0.0	CFS
SW of Pineville Northumberland Co.	20-27(5)-518(4)	F S	-	157.6	427	Miss	389	408	35	41	3.7	CFS

TABLE 17. Spruce budworm pheromone trapping - Maritimes - 1986

Location	UTM Grid	Host	1985 L2	L3-L4 larvae per m	Pheromone trap catch 1	2	3	Ave	Defoliation Visual % Ave	Fettes % Ave	1986[1] L2	CoOp Agency
Bartholomew Northumberland Co. DNRE No. 6	20-27(7)-517(7)	bF	-	13	52	55	98	68	5	7	2.0	DNRE
Bartholomew Northumberland Co.	20-27(2)-517(7)	F S	-	41.6	64	40	31	45	16	9	2.0 3.0	CFS
W of Upper Blackville, Northumberland Co.	20-27(5)-516(7)	F S	-	18.9	309	261	541	370	41	39	20.9 12.3	CFS
W of Shinnickburn Northumberland Co.	20-27(6)-515(9)	F	-	75.6	189	282	315	262	35	30	8.0	CFS
S of Tetagouche, W of Restigouche Co.	19-71(7)-527(4)	bF	9	32	30	Miss	44	37	5	2	2.7	FIDS
Pleasant Valley York Co. DNRE No. 7	19-68(7)-511(9)	S b/r	-	115	488	332	563	461	10	9	7.0	DNRE
Popelogan Lake, W of Restigouche Co. DNRE No. 3	19-67(1)-529(7)	bF	-	98	109	212	152	158	76	75	11.0	DNRE
Mountain Road, Mazerolle Settlement, York Co.	19-66(4)-507(9)	bF	11	151	72	47	105	75	63	56	6.0	FIDS
Juniper Tree Nursery, Carleton Co.	19-64(2)-515(7)	bF	-	0	16	46	27	30	26	20	0.9	JDI
Deersdale, York Co, DNRE No. 8	19-64(9)-514(8)	S b/r	-	45	-	-	-	-	-	-	-	DNRE
Gulguac River Victoria Co. DNRE No. 1	19-63(8)-520(2)	bF	-	128	192	313	229	245	-	-	10.0	DNRE
Plaster Rock-Renous Hwy., Little Wapske Rd, Northumberland Co.	19-63(7)-519(6)	bF	15	45	33	14	28	25	7	7	0.0	FIDS
Boston Brook Airstrip, Victoria Co.	19-60(4)-525(3)	F S	-	14.2	?	?	?	121	10	11	9.8	CFS
Black Brook area Victoria Co.	19-60(2)-523(6)	bF	-	5.2	3	-	1	2	21	20	3.2	JDI
Veneer Siding Gate, Victoria Co.	19-59(7)-524(0)	F S	-	22.7	?	?	?	787	15	12	15	CFS

TABLE 17. Spruce budworm pheromone trapping - Maritimes - 1986

Location	UTM Grid	Host	1985 L2	L3-L4 larvae per m	Pheromone trap catch 1	2	3	Ave	Defoliation Visual % Ave	Fettes % Ave	1986[1] L2	CoOp Agency
Kedgwick Forks Restigouche Co. DNRE No. 2 Nova Scotia	19-58(3)-530(3)	bF	-	44	301	226	334	290	-	-	8.3	DNRE
Mile 20, Highlands Road, Victoria Co.	20-66(9)-514(0)	bF	-	3	11	11	15	12	1	-	0.0	FIDS
Mile 4, Highlands Road, Victoria Co.	20-66(6)-511(5)	bF	-	2	1	2	1	1	4	-	0.7	FIDS
S Cape Breton Highlands, Inverness Co.	20-62(4)-511(1)	bF	-	3	3	1	0	2	0	-	0.0	FIDS
Twin Lake on Third Lake Road Guysborough Co.	20-58(1)-501(0)	bF	-	1	0	0	0	0	1	1	1.0	FIDS
Springhill Cumberland Co.	20-41(1)-505(4)	rS	-	53.1	180	90	257	176	24		786*	NSLF
Southampton Cumberland Co.	20-41(1)-504(8)	rS	—	3.8	18	26	Miss	22	4		77*	NSLF
Thunder Hill Cumberland Co.	20-39(5)-505(1)	rS	-	3.0	47	48	47	47	10		722*	NSLF
Halfway River Cumberland Co.	20-39(1)-504(1)	rS	-	30.5	18	12	16	15	39		111*	NSLF
Diligent River Cumberland Co.	20-38(6)-502(8)	bF	-		122	101	Miss	111	56		265*	NSLF
Woodville, NE of Ross Corner, Kings Co.	20-37(1)-500(0)	bF wS	-	5	4	4	7	5	0 4	1 1	0.9	FIDS
Sand Lake, Queens Co.	20-32(1)-490(1)	bF rS	-	0	0	0	0	0	0 0	0 1	0.0	FIDS
Prince Edward Island												
Mount Vernon, Queens Co.	20-51(8)-509(5)	bF	12	71	183	228	241	217	50	-	7.6	FIDS

[1]Larvae/branch.
*Larvae/10m2.

OTHER INSECTS AND DISEASES

OTHER INSECTS AND DISEASES

This table lists, alphabetically by common name, most insects and diseases encountered in the Maritimes in 1986 but not discussed in detail elsewhere in the report. Inclusion in the table does not imply that the organism is necessarily of lesser economic importance than those discussed in the text. It may be that an organism, e.g., larch sawfly, is at an ebb of biological activity and did not cause enough concern in 1986 to warrant detailed discussion. It may be that although severe, an organism, e.g., elm leaf beetle, was only of localized importance in 1986.

INSECT OR DISEASE	HOST(S)	LOCALITY	REMARKS
Abiotic conditions Flooding	Balsam fir Cedar Hardwoods Spruce	N.B. N.S.	Activities such as dam building by beavers and road construction caused mortality of a variety of tree species in northern New Brunswick and eastern Nova Scotia.
Roadside salt damage	Conifers	Region	Foliage reddening, mainly of white pine and to a lesser extent red pine present throughout New Brunswick and Nova Scotia. Other hosts affected to a lesser extent were Scots pine, eastern hemlock, spruce and fir. In Prince Edward Island, white spruce, cedar, red pine and Scots pine were severely and moderately discolored in parts of Prince and Queens counties.
Frost	Conifers Hardwoods	Region	Damage was widespread and severe on current balsam fir and spruce foliage throughout much of eastern New Brunswick, resulting in a 40 - 50% reduction in the Christmas tree harvest, where up to 70% of new shoots were destroyed in some stands. In Nova Scotia damage ranged from 15 to 85% of current balsam fir foliage in areas of Antigonish, Guysborough, Halifax, Pictou and Cumberland counties. In Prince Edward Island up to 90% of new white spruce foliage was affected on 60% of the trees in two small areas in Queens County, moderate and severe damage elsewhere including 80% of trembling aspen foliage on a few trees at Granville, Queens County.
Hail	Balsam fir	N.B.	A few trees had broken branches in a 0.25 ha area near Burnthill Brook, Carleton County.
Ice and sleet	Tamarack White pine	N.S.	Tops and limbs were damaged over several square kilometres in the Garden of Eden Barrens in Pictou and Guysborough counties.
Mineral deficiency	Jack pine White pine	N.B.	What appeared to be mineral deficiency caused foliage discoloration of 50% of roadside pine trees in the Crow Hill area, York County and discoloration of 1984 and 1985 foliage of white pine at Kouchibouguac National Park, Kent County.
Ocean salt spray	Alder Cherry Red maple White birch	N.S.	Moderate foliage browning common at Black Brook Cove, Victoria County.
Snow damage	Jack pine Red pine White pine	N.B. N.S.	Snow broke branches and tops on 5% of jack pine trees in a 40-ha plantation at Napadogan, also present at South Tay, and on the North Branch of the Keswick River, York County, New Brunswick. In Nova Scotia, 64% of white pine trees were damaged at Garden of Eden Barrens, Guysborough County; 28% of white pines at Bryden Brook, Pictou County; and 68% of jack pine at Black Brook Cove, Victoria County.

INSECT OR DISEASE	HOST(S)	LOCALITY	REMARKS
Wind damage	Conifers Hardwoods	Region	Strong winds in northern New Brunswick in early June damaged up to 72% of hardwood foliage in some areas. Scattered softwood trees were blown down along roadsides and at the edges of cutover areas especially in the Half-way Depot, Summit Depot to Kedgwick areas of Madawaska and Restigouche counties. In Nova Scotia, a few scattered trees were affected at Whycocomagh, Inverness County and St. Peters, Richmond County. Light damage of red maple foliage occurred on a few trees at Summerside, Prince County and Meadowbank, Queens County, Prince Edward Island.
Winter drying	Balsam fir Black spruce Cedar Jack pine Red pine Scots pine White pine White spruce	N.B. P.E.I.	In New Brunswick, severe and moderate browning of Scots pine at Prime and near St. Basile, Madawaska County, of 40% of Scots pine at Lower Caverhill, York County. The tops of 75% of black spruce in a transplant bed were moderately browned at Juniper, Carleton County; and up to one-third of red spruce foliage on understory trees at a location on the Dungarvon Road, Northumberland County. In Prince Edward Island, severe foliage browning on various tree species in scattered locations throughout the Province, at Dalvay Beach, Queens County, 40% of red pine were affected.
Alder flea beetle *Altica ambiens alni* Harr.	Alder	Region	Overall intensity declined in western New Brunswick but moderate and severe patches of browning extended from Charlotte County in the south to Edmundston, Madawaska County in the north. Numerous patches of light, moderate and severe browning were noted throughout Pictou, Antigonish, and Victoria counties becoming scattered patches along roadsides and in old fields in southwestern Nova Scotia. Populations remained low in Prince Edward Island except for small patches of severe browning at Brookvale and North Granville, Queens County and between Montague and Valleyfield, Kings County.
Ambermarked birch leafminer *Profenusa thomsoni* Konow	White birch	N.B. N.S.	In New Brunswick, low populations at two locations in Kent County, one each in St. John and York counties. In Nova Scotia, a low population affecting 4% of leaves at one location in Queens County.
Animal damage Porcupine	Balsam fir Beech Jack pine Red pine Sugar maple Tamarack White pine	N.B. N.S.	Common throughout New Brunswick and Nova Scotia. About 13% of trees damaged at 14 locations in New Brunswick. Damage ranged from 16 to 63% in affected pine plantations in eastern Nova Scotia and up to 92% in the western part of the Province.
Rabbit	Black spruce Jack pine	N.B.	Rabbits girdled and killed a few scattered young trees in a plantation at Forks Stream, Queens County, scattered trees at Keswick River and a few black spruce along Napadogan Stream, York County.
Deer	Balsam fir	N.B.	Moderate and light browning in a Christmas tree stand at Clair, Madawaska County.
Squirrel	Jack pine	N.B.	Squirrels removed cones from a few trees causing red flagging on up to 1% of branches along the South Tay River, York County. Also at numerous other locations scattered throughout the Province.
Ash yellows	Ash	Region	This disease, caused by a mycoplasma-like organism, has not been found in the Region to date. This disease is present in the United States and is a concern for plant quarantine officials.

INSECT OR DISEASE	HOST(S)	LOCALITY	REMARKS
Aspen leafrollers *Epinotia criddleana* (Kft.) *Pseudexentera oregonana* (Wlshm.)	Largetooth aspen	Region	Leafrolling, mostly of trembling aspen, common throughout the Region but restricted mainly to trace and light levels.
Darkheaded aspen leafroller *Anacampsis innocuella* (Zell.)			
Lightheaded aspen leafroller *Anacampsis niveopulvella* (Cham.)			
Spotted aspen leafroller *Pseudosciaphila duplex* (Wlshm.)			
Aspen webworm and lesser aspen webworm *Tetralopha aplastella* (Hlst.) and *Meroptera pravella* (Grt.)	Aspen	Region	Negative in 1986. This decline is connected with the overall decine in forest tent caterpillar throughout the Region.
Bagworm *Thyridopteryx ephemeraeformis* (Haw.)	Spruce	N.S.	Found at Bridgewater, Lunenburg County. This is a new record for the Province.
Balsam bark weevil *Pissodes dubius* Rand.	Balsam fir Red spruce White spruce	Region	In New Brunswick, common on dead and dying balsam fir and to a lesser extent on white spruce and red spruce. About 13% of balsam fir affected at 25 locations in 12 counties. At Dalvay, Queens County, Prince Edward Island of 25 white spruce trees examined 16% were dead and 12% living but infested. In Nova Scotia, found on balsam fir at locations in Inverness, Guysborough and Halifax counties.
Balsam fir sawfly *Neodiprion abietis* (Harr.)	Balsam fir Black spruce Red spruce	N.S. N.B. P.E.I.	Present in low numbers at a few locations scattered throughout the Region.
Balsam fir root aphid *Prociphilus americanus* (Walker)	Balsam fir	N.B.	Present in Christmas tree plantations at Connors, Madawaska County, and Cape Spear, Westmorland County.
Balsam shootboring sawfly *Pleroneura brunneicornis* Roh.	Balsam fir	N.B. N.S.	In New Brunswick, an average of 3% of shoots were infested at 15 scattered locations; in Nova Scotia, 0.6% at 22 locations.
Balsam woolly adelgid *Adelges piceae* (Ratz.)	Balsam fir	Region	In New Brunswick, very light stem attack was reported from three locations, one each in Charlotte, St. John, and York counties. In Nova Scotia, the insect continued to deform trees, especially in coastal areas, causing gouty twigs and umbrella tops. Stem attack was present on 25% of the trees at Marie Joseph, Guysborough County. One location in southern Kings County, Prince Edward Island has very light stem wool.

INSECT OR DISEASE	HOST(S)	LOCALITY	REMARKS
Beech bark disease *Nectria coccinea* var. *faginata* Lohm., Wats. & Ayers Beech scale *Cryptococcus fagisuga* Lind.	Beech	Region	Cankered trees remain common throughout the Region. In New Brunswick, at 14 locations infections ranged from 32% of trees at Allardville to 100% at Allardville East, Gloucester County, elsewhere five widely scattered locations had from 90-100% of trees cankered. At Scotch Hill, Pictou County, Nova Scotia, 100% of trees were severely cankered.
Birch sawfly *Arge pectoralis* (Leach)	White birch	N.B. N.S.	In New Brunswick at Martin Head, St. John County an average of 16% of the leaves were affected on about half of the trees. Found at four locations in eastern Nova Scotia, but noticeable leaf damage was restricted to one area at MacIntosh Brook, Inverness County where the insect was present in combination with the birch skeletonizer, which was the more common organism.
Bruce spanworm *Operophtera bruceata* (Hlst.)	Sugar maple Red maple	Region	Populations decreased throughout the Region. In New Brunswick, light defoliation occurred on sugar maple at scattered locations in Restigouche and Gloucester counties. Populations were negligible in Nova Scotia. Not found in Prince Edward Island.
Cedar leafminers *Argyresthia aureoargentella* Brower *Argyresthia trevella* Wlshm. *Coleotechnites thujaella* (Kft.)	Cedar	N.B. P.E.I.	In Prince Edward Island, occurrence and abundance of leafminers increased in Prince County. Virtually all stands between O'Leary in the northwest part of the county and Summerside in the southeast sustained moderate or severe leaf browning. Chronic attack in the Miscouche, Muddy Creek, Sandy Cove areas has resulted in many dead branches and tree mortality. In New Brunswick, attack was concentrated in parts of Charlotte and St. John counties (see Deterioration of cedar).
Cherry casebearer *Coleophera pruniella* Clem.	Trembling aspen	P.E.I.	The number of locations with damage decline dramatically from 1985. Three locations in Kings County and one in Queens County had moderate browning.
Cherry blight	Pin cherry	P.E.I. N.S.	Continued moderate and severe damage at many locations in Kings and Queens counties and a few locations in Prince County, Prince Edward Island. Light and moderate damage was common and widespread throughout Nova Scotia.
Condition of spruce	White spruce	N.B.	Mature spruce trees in the Robinsonville area of Restigouche County, weakened by repeated spruce budworm attacks over the years are being attacked and killed by stem weevils, horntails, bark beetles, whitespotted sawyer beetles, and Armillaria root rot. The area affected covers about 144 km2 and is bordered on the west by the Restigouche and Upsalquitch Rivers and extends from Robinsonville in the south, to Flatlands in the north and east to near Christopher Brook.
Conifer aphids *Cinara* spp.	Balsam fir Black spruce Eastern white pine Jack pine Red spruce Tamarack White spruce	Region	Common throughout the Region, sometimes affecting the majority of trees in localized situations, but causing little damage.

INSECT OR DISEASE	HOST(S)	LOCALITY	REMARKS
Deterioration of cedar	Eastern cedar	N.B.	Many cedars with thin crowns and some tree mortality in parts of Charlotte and St. John counties, with the heaviest concentration of damage east of Saint John city. The cedar leafminer, *Argyresthia aureoargentella* Brower has been present for more than one year and was the most abundant organism found, a species of spider mite, *Tetranychidae*, cedar leaf blight *Didymascella thujina* (Durand) Maire, and the cedar tree borer, *Semanotus ligneus* (F.) were also present. It is however, not certain, if these organisms are fully responsible for the condition.
Dieback of ash	Ash	N.B.	This condition persisted at Robinsonville, Restigouche County and Tetagouche River, Gloucester County, where top and branch mortality continued to occur on many trees.
Early leaf browning	Largetooth aspen	N.S.	Premature leaf browning and crown deterioration in forest stands east of Garlands Crossing and near Mill Section, Hants County. Leaf spot fungi were present as were a few twig cankers, of uncertain origin. The exact cause of the condition is as yet unexplained.
Eastern blackheaded budworm *Acleris variana* (Fern.)	Balsam fir Spruce	P.E.I.	Present in low numbers throughout the Region.
Eastern dwarf mistletoe *Arceuthobium pusillum* Peck	Black spruce White spruce	Region	Present at low levels throughout the Region.
Eastern tent caterpillar *Malacosoma americanum* (F.)	Apple Cherry	Region	Populations very low in New Brunswick and Prince Edward Island. Present at low levels in eastern Nova Scotia and in Hants, Kings and Annapolis counties, in the western part of the Province.
Elm leaf beetle *Pyrrhalta luteola* (Mull.)	Elm	N.B.	Browning of shade trees was present again in Fredericton, York County, but much less severe than in 1985.
Elm leafminer *Fenusa ulmi* Sund.	English elm	Region	In Nova Scotia, leaf browning of various intensity, sometimes severe in Cape Breton, Pictou, Colchester, Hants, Queens and Cumberland counties. Intensity of attack in Truro was reduced for the second year. In Prince Edward Island, severe browning in all three counties, with 80-90% at Montague, Kings County. In New Brunswick, light browning on a few trees at Dorchester and Sackville, Westmorland County.
European pine sawfly *Neodiprion sertifer* (Geoff.)	Mugho pine Red pine Scots pine	Region	Present at low numbers on ornamentals in all three provinces.
European pine shoot moth *Rhyacionia buoliana* (D. & S.)	Red pine Scots pine	Region	Populations were generally low in most of the Region but a red pine plantation at Beauly, Antigonish County, Nova Scotia, had an average of 36% of shoots damaged. At Quispamsis, Kings County, New Brunswick, severe damage made red pine in a 1-ha Christmas tree plantation unmarketable. In Prince Edward Island, young plantations showed a noticeable increase in damage in the central and eastern areas of the Province. At Fort Augustus, Granville, Roseberry and Caledonia, Queens County, 90-100% of the trees were infested with up to 60% shoot damage in 0.5- to 1.0-ha plantations.

INSECT OR DISEASE	HOST(S)	LOCALITY	REMARKS
European spruce sawfly *Gilpinia hercyniae* (Htg.)	Spruce	Region	Populations remained low throughout the Region, except at the permanent plots at the Acadia Forest Experiment Station, Sunbury County, New Brunswick where larvae per tree have shown a steady increase as follows: 1st generation: 1983 0.00; 1984 0.13; 1985 0.60; 1986 1.83 2nd generation: 0.20; 0.56; 1.90; 6.16 There have been several brief peaks during the 49 years of continuous monitoring since the very damaging outbreak collapsed in the late 1930s.
Fall webworm *Hyphantria cunea* (Dru.)	Deciduous	Region	In Nova Scotia, nests were common again on roadside bushes in Yarmouth, Digby and Queens counties. Nests were common in Prince Edward Island but did not exceed 1 km except at Fort Augustus and between Bethel and Mount Herbert, Queens County with 5 and 7 nests/km, respectively. There was one collection from Gloucester County, New Brunswick.
Fall hornworm *Pheosia rimosa* Pack. Rustylined leaftier *Clostera albosigma* Fitch Pepper and salt moth *Biston betularia cognataria* (Gn.)	Trembling aspen	N.B. N.S.	The area that sustained moderate and severe defoliation northeast of Salem Road, Cape Breton County Nova Scotia in 1985 had light defoliation.
Foureyed spruce bark beetle *Polygraphus rufipennis* (Kby.)	Black spruce Red spruce White spruce	N.B.	Observed at eight locations in New Brunswick including 20% of red spruce in a 5 ha area of Fundy National Park and 12% of red spruce at a location on the South Dungarvon River, Northumberland County. At Peabody Lake, Northumberland County, 8% of white spruce were infested and 4% of black spruce at Acadia Forest Experiment Station, Sunbury County.
Globose gall rust *Endocronartium harknessii* (J.P. Moore) Y. Hiratsuka	Jack pine Lodepole pine Scots pine	Region	Common in many areas of New Brunswick where an average of 35% of the trees were infected at 10 locations with a range of infection from 5 to 20%. In Prince Edward Island, it was present at three locations at low levels and one location also at low levels in Nova Scotia.
Hypoxylon canker *Hypoxylon mammatum* (Wahl.) J.E. Miller	Trembling aspen	Region	Near Brockway, York County,New Brunswick, 64% of trees were infected. Light infections were found at nine locations, two each in Kent, York, and Northumberland counties, and one each in Westmorland, Carleton, and Madawaska counties. Trace infections were found at two locations, one each in York and Victoria counties. In Nova Scotia, it is omnipresent with 12% infection at West Linwood, Antigonish County the highest found. In Prince Edward Island, moderate infection at Harmony, and light infections at two other locations in Prince County, one light and one trace at two locations in Queens County.
Jack pine budworm *Choristoneura pinus pinus* Free.	Jack pine	N.B.	A few scattered trees were moderately defoliated while remaining trees sustained trace at Little Forks Brook, Kent Co. Elsewhere defoliation was trace to light.

INSECT OR DISEASE	HOST(S)	LOCALITY	REMARKS
Larch needleworm *Zeiraphera improbana* (Wlk.)	Tamarack	N.S.	Trace to moderate defoliation was observed at the Garden of Eden Barrens, Guysborough County. Populations elsewhere low except on Cape Breton Island where 20-40 ha of moderate to severe defoliation was found in the St. Peters Junction - Port Richmond -Port Malcolm area of Richmond County.
Larch sawfly *Pristiphora erichsonii* (Htg.)	Tamarack	Region	Populations remained low throughout the Region. Found at two locations each in New Brunswick and Nova Scotia, and at one location in Prince Edward Island, defoliation did not exceed light.
Large aspen tortrix *Choristoneura conflictana* (Wlk.)	Largetooth aspen Trembling aspen	Region	Leafrolling at low levels at scattered locations except two areas in Pictou County, Nova Scotia where the insect caused moderate damage over about 70 ha. In the area near Granton, Pictou County, the forest tent caterpillar was also involved.
Leaf blotch of horse-chestnut *Guignardia aesculi* (Peck) V.B. Stew.	Horse-chestnut	Region	Browning was widespread and variable on foliage wherever horse-chestnut was found in the Region. In New Brunswick, only light and moderate browning was present on Deer Island, Campobello Island and St. Stephen, Charlotte County; this represents a significant decline from 1985. In Nova Scotia, light and moderate damage was observed at Whycocomagh and Mabou, Inverness County, Baddeck, Victoria County, Sydney, Cape Breton County, Plainfield and Poplar Hill, Pictou County. Damage did not exceed light elsewhere in the Province. In Prince Edward Island, severe browning was observed at Montague and Kilmuir, Kings County, moderate and severe at St. Eleanors, Norboro and Summerside, Prince County, Souris and Sturgeon, Kings County and Belfast and Marshfield, Queens County. Foliage discoloration did not exceed light elsewhere.
Leaf rollers on birch *Caloptilia* sp.	White birch Yellow birch	N.B.	Populations continued to increase and cause significant leaf rolling of white birch and to a lesser extent yellow birch throughout much of the northern half of New Brunswick and was also more damaging and widespread in much of the southern part of the Province.
Leaf spot of poplar *Drepanopeziza tremulae* Rimpau	Trembling aspen	N.S. P.E.I.	The moderate and severe leaf browning reported from locations in Richmond County, Nova Scotia disappeared in 1986; at North River and North Wiltshire, Queens County, Prince Edward Island, only to light discoloration on a few trees.
Leaf and twig blight of aspen *Venturia macularis* (Fr.) Muell. & Arx	Trembling aspen	N.B. P.E.I.	Common throughout New Brunswick where an average of 15% of shoots was damaged at 35 scattered locations. In Prince Edward Island, found at low levels at five locations.
Maple leafroller *Sparganothis acerivorana* MacK.	Red maple Sugar maple	Region	In Prince Edward Island, populations and damage increased, at 39 locations leafrolling averaged 38%; common throughout New Brunswick but leafrolling was light, averaging less than 10% at 59 locations; in Nova Scotia populations were low.
Mountain ash sawfly *Pristiphora geniculata* (Htg.)	Mountain-ash	Region	In Prince Edward Island, moderate defoliation was observed at Brackley Beach, Stanhope, New London, and Springfield, Queens County, and Montague, Kings County; in Nova Scotia and New Brunswick various levels of defoliation, typically trace and light.

INSECT OR DISEASE	HOST(S)	LOCALITY	REMARKS
Northern pitch twig moth *Petrova albicapitana* (Busck)	Jack pine Lodgepole pine	Region	In New Brunswick, present in jack pine plantations and stands although numbers were usually not high, pitch masses were easy to find. The highest numbers occurred at Forks Stream, Sunbury County, where nodules were found on 70% of the trees with 20% at a location near Allardville, Gloucester County. Numbers were very high on lodgepole pine at Acadia Forest Experimental Station, Sunbury County, where all trees were infested in a small plantation and a few killed by repeated attacks. In Nova Scotia, the highest incidence was at Black Brook Cove, Victoria County, where 60% of the trees had 1-2 nodules each. In Prince Edward Island, a few nodules were found on jack pine at Fort Augustus, Queens County.
Obliquebanded leafroller *Choristoneura rosaceana* (Harr.)	Largetooth aspen Mountain maple Red maple Sugar maple Trembling aspen White birch Yellow birch	Region	Caused light defoliation at scattered locations in New Brunswick, eastern Nova Scotia, and Prince Edward Island.
Orangehumped mapleworm *Symmerista leucitys* Francl.	Beech Sugar maple	N.S	The population decline first noted in 1985 continued and the insect is now at endemic levels.
Pine leaf adelgid *Pineus pinifoliae* (Fitch)	Red spruce White spruce	N.S.	Although common in 1985, six of seven locations sampled in 1986 were negative. At West Gore Road, Hants County, 4% of white pine shoots were affected.
Poplar leaffolding sawfly *Phyllocolpa* sp.	Trembling aspen	Region	Present throughout most of New Brunswick, counts made at 15 locations in eight counties averaged 9% of the leaves affected and ranged from 3 to 11% on 60% of the trees. In Prince Edward Island, an average of about 28% of the leaves were folded at 12 locations scattered throughout the Province. Occurred at a few locations in Colchester and Pictou counties, Nova Scotia, with 9% the highest percentage of leaves affected.
Poplar petiolegall moth *Ectoedemia populella* Busck	Trembling	P.E.I.	Present throughout the Province. At Dalvay, Queens County, about 15% of leaf petioles were infested.
Premature needle loss	Black spruce Red spruce	N.B.	Loss of 1985 foliage in plantations in parts of Victoria and Madawaska counties. Further study is required to determine the cause of this problem.
Saddled prominent *Heterocampa guttivitta* (Wlk.)	Sugar maple	N.S. N.B.	Light defoliation on sugar maple, 7.5 km northwest of Economy Lake, Colchester County, Nova Scotia. The scattered areas of defoliation noted in Pictou and Antigonish County, Nova Scotia in 1985 disappeared. Several larvae collected at Berryton, Albert County, New Brunswick.

INSECT OR DISEASE	HOST(S)	LOCALITY	REMARKS
Satin moth *Leucoma salicis* (L.)	Carolina poplar Silver poplar Trembling aspen	Region	At Popple Depot, Northumberland County, New Brunswick, about 100 ha of trembling aspen had moderate defoliation, with a central 10 ha area of severe defoliation. This is the same outbreak area reported in 1984 which subsided in 1985 and then increased in 1986. Ornamental Carolina poplars were severely defoliated in New Maryland, York County. In Prince Edward Island, defoliation subsided at Hunter River, Queens County, but persisted and caused severe defoliation of silver poplar at St. Anthony, Prince County. Severe spot defoliation of ornamentals was noted at Cherry Valley, North Rustico, near Kingston, Queens County and Five Houses, Kings County. Defoliation reported in 1985 in Hants County, Nova Scotia subsided and the entire Province had very low populations.
Spring cankerworm *Paleacrita vernata* (Peck)	Elm	N.S.	Light and moderate defoliation was noted on ornamental elm trees at Windsor and Hantsport, Hants County, Kentville, and near Kingston, Kings County, and Middleton, Annapolis County.
Spruce bud midge *Rhabdophaga swainei* Felt	Black spruce White spruce	Region	Populations remained low but were widespread throughout the Region. Numbers were highest at Askilton, Inverness County, Nova Scotia, where 11% of the buds were infested on 5% of the white spruce trees. In Prince Edward Island, infestations ranged up to 8% of buds on 40% of white spruce trees at Brookvale and Mount Vernon, Queens County. In New Brunswick, 5% of the buds were infested on 70% of white spruce at one location in Madawaska County.
Spruce bud scale *Physokermes piceae* (Schr.)	Balsam fir Black spruce Red spruce White spruce	N.B.	Present at various levels of intensity in plantations, natural forests and ornamentals at locations scattered throughout the Province. The highest infestation level occurred in a black spruce plantation in Victoria County where 25 to 100% of the shoots were attacked on all trees examined.
Spruce coneworm *Dioryctria reniculelloides* Mut. & Mun.	Spruce	Region	Populations remained low.
Striped alder sawfly *Hemichroa crocea* (Geoff.)	Alder	Region	Severe defoliation occurred in a 2-ha area at Grand Harbour, Charlotte County, New Brunswick, in a small area of Keppoch, Pictou County, Nova Scotia, and moderate defoliation of scattered alders at Goose River, Kings County, Prince Edward Island.
Sugar maple borer *Glycobius speciosus* (Say)	Red maple Sugar maple	N.B.	Twenty-one sugar maple locations were assessed in New Brunswick. At Ammon Road, Westmorland County, 36% of the trees were damaged. Elsewhere in the Province, damage at eight locations ranged from 12-25%, seven locations were 4 to 8% and five locations were negative. Six red maple locations were assessed in New Brunswick with 20% of the trees damaged at Upper Buctouche, Kent County and four locations with 4 to 8% damage and one location negative.
Sulphur dioxide damage	Hardwoods Conifers	N.B.	Damage to various tree species with moderate and severe in some conifer plantations near a base metal smelter in Gloucester County.
Target canker (probably a *Nectria*)	Red maple Sugar maple White birch	N.B.	Present on 7.5% of sugar maples in eight stands in six counties in the eastern part of the Province, also present on 8% of red maple in a stand in Kent County. At Magaguadavic Lake, York County, 32% of white birch stems were cankered.

INSECT OR DISEASE	HOST(S)	LOCALITY	REMARKS
Tip blight of balsam fir *Delphinella balsameae* (Waterm.) E. Muell.	Balsam fir	N.S. N.B.	A few scattered trees were affected near Earltown Lake, Colchester County. Not found in New Brunswick where up to 75% of current shoots were affected on scattered trees in Fundy National Park, Albert County, in 1985.
Uglynest caterpillar *Archips cerasivorana* (Fitch)	Cherry	Region	In New Brunswick, a nest count of 35/100 m^2 was made at Tay Mills, York County. At three scattered locations in Kings, York and Victoria counties, nest counts were 7, 2, and 3/100 m^2 respectively. Numbers were low elsewhere in the Region.
Wax filament scale *Xylococculus betulae* (Perg.)	Beech White birch	N.B. N.S.	Moderate and light infestations on white birch at 10 locations in New Brunswick; present on 80% of beech trees at Scotch Hill, Pictou County, Nova Scotia, and in a few beech stands in New Brunswick. See also Deterioration of birch.
White pine cone beetle *Conophthorus coniperda* (Sz.)	White pine	N.B.	This insect causes loss of 2nd year cones by attacking the base of the cone stem causing infested cones to shrivel and drop. At Fredericton Junction, and in the Burpee Game Management Area, Sunbury County, cone losses were 95% and 30 to 40%, respectively, at mid-season. Damage was also reported near Doaktown, Northumberland County, and Cranberry Lake, Queens County. The loss of cones and seed is a matter of concern since some white pine is now included in planting programs.
White pine blister rust *Cronartium ribicola* J.C. Fisch.	White pine	N.B.	Continues to be present in white pine throughout New Brunswick. Near Brockway, York County, 88% of the trees in a small area were affected, and 48% at Scotch Ridge, Charlotte County. In Restigouche County, 60% of small trees are affected in an area near the southeast Upsalquitch River. Elsewhere forest trees and ornamentals were affected at scattered locations.
White pine needle blight	White pine	Region	This condition was not as common in New Brunswick as in 1985 but affected scattered trees throughout the Province at low levels of intensity. In Nova Scotia, up to 80% of the trees were lightly affected in the Rossignol Lake area of Queens County and in Prince Edward Island, one tree was moderately browned at Brookvale, Queens County.
White pine weevil *Pissodes strobi* (Htg.)	Jack pine Scots pine White pine White spruce	Region	Present throughout the region. In Charlotte County, New Brunswick, 100% of white pine were infested at Scotch Ridge, and 92% at Brockway, York County, 20% of white pine in a small area of Kouchibouguac National Park, Kent County and various levels of infestation at numerous other locations in the Province. In Nova Scotia, 44% of white pine were affected in an area of Kejimkujik National Park, Queens and Annapolis counties, 8% of white pine at Hunters Mountain, Victoria County and Garden of Eden Barrens, Guysborough County. In Prince Edward Island, a few white pine leaders were affected at Brookvale, Queens County, on 10% of white spruce near Dalvay, in the Prince Edward Island National Park, and on a few white spruce at Howards Cove, Prince County.
Whitespotted sawyer *Monochamus scutellatus* (Say)	Balsam fir White spruce	N.B. N.S.	Red flagging of balsam fir shoots caused by adult feeding on the underside of small branches was common on all ages of trees in western New Brunswick. Populations were high in dead and dying trees in much of western and northern New Brunswick where more than 8% of fir stems in some areas were infested. In Nova Scotia, many balsam fir trees were infested on the Highlands area of Inverness and Victoria counties.

INSECT OR DISEASE	HOST(S)	LOCALITY	REMARKS
Willow blight *Venturia saliciperda* Nuesch	Willow	Region	Present at low levels in New Brunswick. In Nova Scotia severe browning throughout the western half of the Province and in various degrees of browning in Colchester, Pictou, Antigonish and Halifax counties. In Prince Edward Island, up to 80% of foliage was browned at four scattered locations in Prince County and two locations in Kings County.
Willow flea weevil *Rhynchaenus rufipes* (Lec.)	Willow	Region	Severe and moderate browning of ornamental willows in parts of Westmorland, Kent, Madawaska and Northumberland, Gloucester and Restigouche counties, New Brunswick; throughout much of Nova Scotia where bayleaf willow is present; caused severe leaf browning of ornamentals throughout Prince County and at scattered locations in Queens and Kings counties in Prince Edward Island.
Winter moth *Operophtera brumata* (L.)	Deciduous	N.S.	Collected in low numbers from a few widely scattered locations, damage negligible.
Yellowheaded spruce sawfly *Pikonema alaskensis* (Roh.)	Black spruce White spruce	P.E.I.	In Prince Edward Island, up to 9% mortality of black spruce with defoliation ranging from light to severe on 75% of remainder in a 1.5-ha area at Dromore, Queens County. Near Peaks, Kings County populations increased and caused up to 70% defoliation of 11% of trees and with lower levels on 60% in a 5-ha, 9 year-old black spruce plantation. Populations collapsed at four locations in Queens County where light and moderate defoliation occurred in 1985.

ACKNOWLEDGEMENTS

This report is the result of the combined effort of all members of the Forest Insect and Disease Survey; L.J. Coady, J.R. Cormier, C.B. Dobson, K.J. Harrison, J.E. Hurley, A.M. Jones, C.D. MacCall, A.W. MacKay, L.P. Magasi, O.A. Meikle, W.R. Newell, D.P. Ostaff, B.A. Pendrel, S.E. Pond, and F.A. Titus. We wish to thank our summer students and the numerous staff members at CFS-Maritimes who contributed in many ways. Some are mentioned in the appropriate sections of the report but special thanks go to Marg Cameron, Ed Kettela, Don Marks, and Thaddee Renault. Much of the information on the control of the spruce budworm is based on data provided by other organizations as listed in the appropriate chapters.

Information contributed by the Pest Detection Officers of the New Brunswick Department of Natural Resources and Energy, the Nova Scotia Department of Lands and Forests, and the Prince Edward Island Department of Energy and Forestry is acknowledged and appreciated. Special thanks go to those who participated in the gypsy moth survey.

Parks Canada, the Department of Natural Resources and Energy of New Brunswick, the Department of Lands and Forests of Nova Scotia, the Bowater-Mersey Ltd., and private individuals operated light traps during the summer months.

The contribution and cooperation of private citizens and of personnel at all levels of industrial organizations, various municipalities, and educational institutions are noted with thanks. Their effort on our behalf in so many ways not only makes our work easier but also makes us a more effective unit.

I would like to express my personal thanks to all my staff who made me 'look good' on many occasions through their hard work and dedication. Special thanks goes from me to Fred Titus who was responsible for producing much of the "table" section of this report.

The year 1986 saw the conclusion to the careers of two of the most senior members of the Forest Insect and Disease Survey. With the retirement of Ray Newell and Lloyd Coady, the unit is losing 75 years of hard work, loyal and dedicated service, accumulated knowledge and experience. While we are sorry to see them go, we are happy for them and wish them well in their well deserved retirement. Congratulations and thank you, Ray and Lloyd!

LIST OF PUBLICATIONS

Reports and publications by the staff of the Forest Insect and Disease Survey and forest pest related articles by other members of CFS-Maritimes produced in 1986. (Contributions without direct FIDS staff involvement are marked by *.)

*Blum, B.A. and MacLean, D.A. 1985. Potential silviculture, harvesting and salvage practices in eastern North America. *In* Recent Advances in Spruce Budworm Research. Proceedings of the CANUSA Spruce Budworm Research Symposium, September 16-20, 1984, Bangor, Maine. CFS, Ottawa, 1985. p. 264-280.

Coady, L.J. 1986. Forest insects and diseases in Prince Edward Island National Park in 1985. CFS-Maritimes Technical Note No. 155.

*Cuff, W. and Walker, H.D. 1985. Integration of forest management and pest management in the eastern Provinces of Canada. *In* Recent Advances in Spruce Budworm Research. Proceedings of the CANUSA Spruce Budworm Research Symposium, September 16-20, 1984, Bangor, Maine. CFS, Ottawa, 1985. p. 443-464.

Embree, D.G. and Pendrel, B.A. 1986. Biological Control Revisited. Ent. Soc. Can. Bulletin, Vol. 18, No. 1, p. 24-28.

*Estabrooks, G.F. 1986. Witches' broom on balsam fir. CFS-Maritimes Technical Note No. 150.

MacCall, C.D. 1986. Forest insects and diseases in Kejimkujik National Park in 1985. CFS-Maritimes Technical Note No. 154.

MacKay, A.W. 1986. Forest insects and diseases in Cape Breton Highlands National Park in 1985. CFS-Maritimes Technical Note No. 153.

*MacLean, D.A. 1985. Effects of spruce budworm outbreaks on forest growth and yields. *In* Recent Advances in Spruce Budworm Research. Proceedings of the CANUSA Spruce Budworm Research Symposium, September 16-20, 1984, Bangor, Maine. CFS, Ottawa, 1985. p. 148-175.

*MacLean, D.A. and Erdle, T.A. 1986. Development of relationships between spruce budworm defoliation and forest stand increment in New Brunswick. p. 106-115. *In* Environmental Influences on Tree and Stand Increment. *Edited by* D.S. Solomon and T.B. Brann. Proc. of the Mensuration, Growth and Yield Instruments and Methods in Forest Mensuration Workshop. September 23-27, 1985. Durham, NH.

Magasi, L.P. 1986. Forest pest conditions in the Maritimes in 1985. CFS-Maritimes Inf. Rep. M-X-159.

Magasi, L.P. 1986. Highlights of forest pest conditions in the Maritimes in mid-June 1986. CFS-Maritimes Technical Note No. 157.

Magasi, L.P. 1986. Highlights of forest pest conditions in the Maritimes at the end of June 1986. CFS-Maritimes Technical Note No. 158.

Magasi, L.P. 1986. Highlights of forest pest conditions in the Maritimes at the end of July 1986. CFS-Maritimes Technical Note No. 160.

Magasi, L.P. 1986. Highlights of forest pest conditions in the Maritimes in mid-September 1986. CFS-Maritimes Technical Note No. 162.

Magasi, L.P. 1986. Some of the major pests in the forests of Nova Scotia in 1986. CFS-Maritimes Technical Note No. 166.

Meikle, O.A. 1986. Forest insects and diseases in Fundy National Park in 1985. CFS-Maritimes Technical Note No. 151.

Meikle, O.A. 1986. Forest insects and diseases in Kouchibouguac National Park in 1985. CFS-Maritimes Technical Note No. 152.

Newell, W.R. 1986. What's the problem? The detection, recognition and sampling of tree pests. CFS-Maritimes Technical Note No. 156.

*Nigam, P.C. 1985. Early laboratory bioassays in Canada. *In* Recent Advances in Spruce Budworm Research. Proceedings of the CANUSA Spruce Budworm Research Symposium, September 16-20, 1984, Bangor, Maine. CFS, Ottawa, 1985, p. 372.

Ostaff, D.P. 1985. Quantifying effects of spruce budworm damage in eastern Canada. *In* Recent Advances in Spruce Budworm Research. Proceedings of the CANUSA Spruce Budworm Research Symposium, September 16-20, 1984, Bangor, Maine. CFS, Ottawa, 1985. p. 247-248.

Ostaff, D.P. and Newell, W.R. 1986. Early infection of larch populations by the European larch canker *Lachnellula willkommii*. CFS-Maritimes Inf. Rep. M-X-157.

Pendrel, B.A. 1986. Monitoring jack pine budworm using pheromone traps. *In* Jack Pine Budworm Information Exchange Workshop, Manitoba Department of Natural Resources, January 1986, Winnipeg, Man. p. 67-69.

Pendrel, B.A., Smith, T.D., and Magasi, L.P. 1986. Spruce budworm defoliation in Nova Scotia - 1986. CFS-Maritimes Technical Note No. 165.

Pendrel, B.A. and Magasi, L.P. 1986. Spruce budworm defoliation on Prince Edward Island in 1986 and a forecast for 1987. CFS-Maritimes Technical Note No. 167.

*Piene, H. 1985. Growth loss and recovery of balsam fir from spruce budworm defoliation. *In* Recent Advances in Spruce Budworm Research. Proceedings of the CANUSA Spruce Budworm Research Symposium, September 16-20, 1984, Bangor, Maine. CFS, Ottawa, 1985. p. 253-254.

Smith, R.F., Magasi, L.P., and Harrison, K.J. 1986. Cone rust, a potential problem in white spruce seed orchards. CFS-Maritimes Technical Note No. 161.

Teillet, P.M., Leckie, D.G., Ostaff, D., Fedosejevs, G. and Ahern, F.J. 1986. Spectral measurements of tree defoliation. *In* Proc. 3rd Int. Colloq. on Spectral Signatures of Objects in Remote Sensing, Les Arcs, France, December 10-20, 1985. p. 511-516.

*Varty, I.W. and Nigam, P.C. 1985. Spray technology- the biological interphase. *In* Recent Advances in Spruce Budworm Research. Proceedings of the CANUSA Spruce Budworm Research Symposium, September 16-20, 1984, Bangor, Maine. CFS, Ottawa, 1985. p. 410-412.

*Wall, R.E. 1986. Effects of black knot on pin cherry. Can. J. Plant Pathol. 8:71-77.

*Wall, R.E. 1986. Pin cherry and the black knot disease. CFS-Maritimes Technical Note No. 169.

*Wall, R.E. and Simpson, R. 1986. Sirococcus shoot blight - a serious threat to red pine in the Maritimes. CFS-Maritimes Technical Note No. 168.

Note: The Proceedings of the CANUSA Spruce Budworm Research Symposium on "Recent Advances in Spruce Budworm Research" was published in 1985 but because it was not available until after our 1985 report went to press, chapters with CFS-Maritimes contribution are listed here.